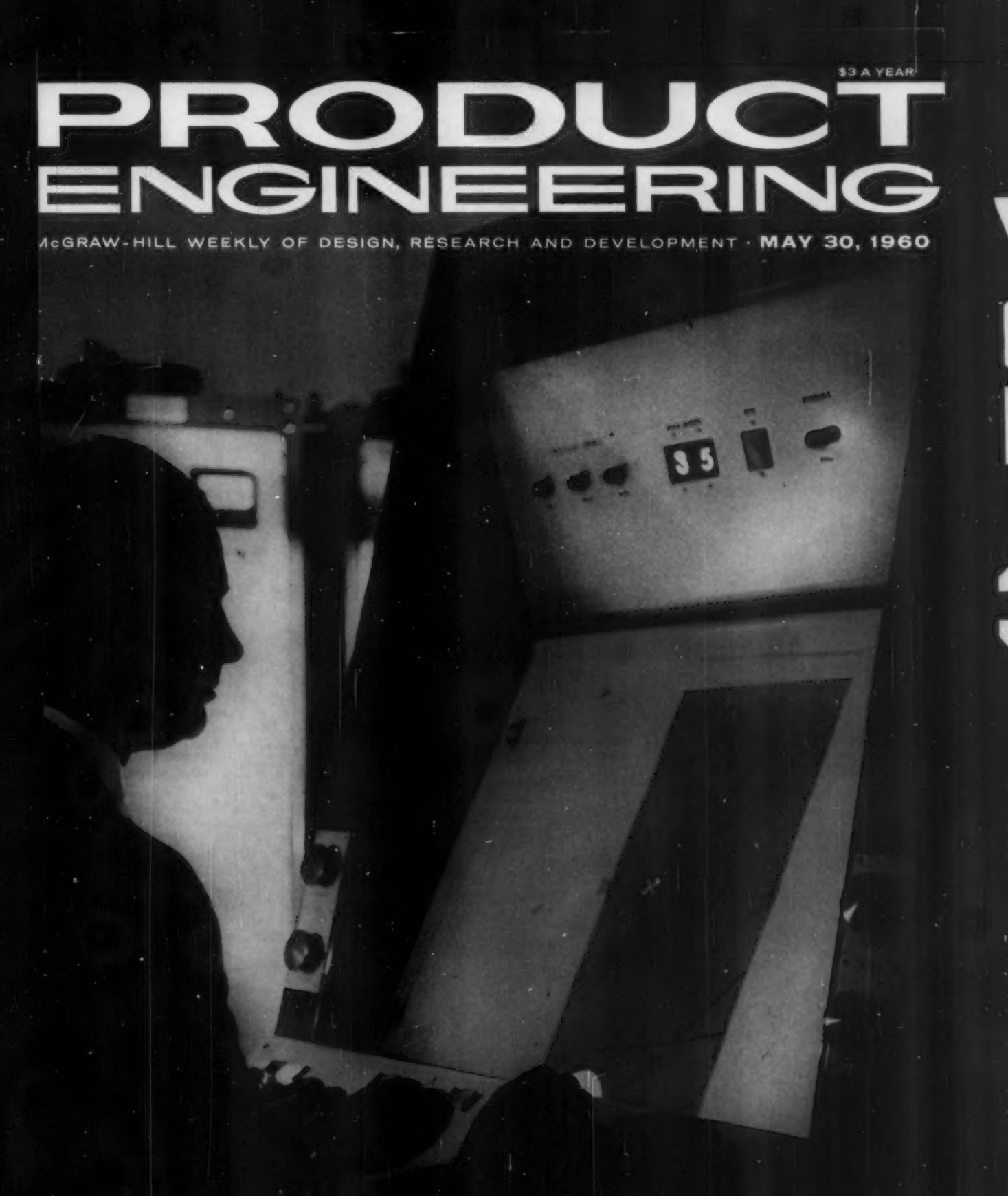
$3 A YEAR

PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT · MAY 30, 1960



Projector plots path of moving objects... *see page 3*

Announcing

a new and better solenoid valve in the $\frac{1}{8}$" and $\frac{1}{4}$" size range

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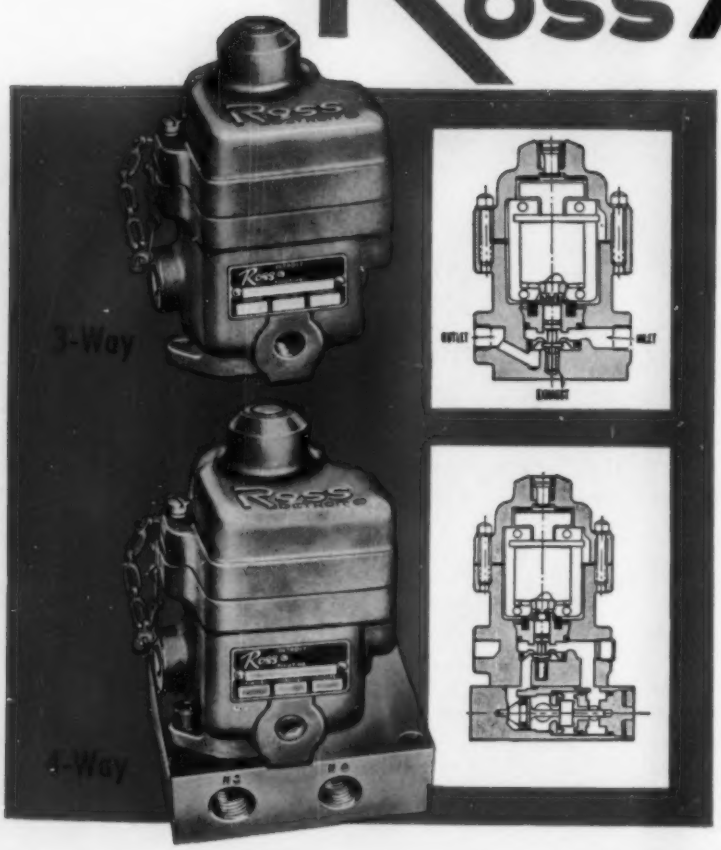

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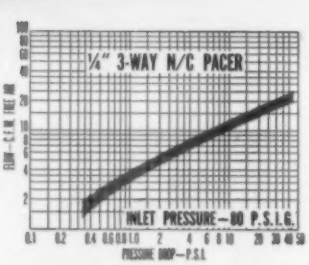
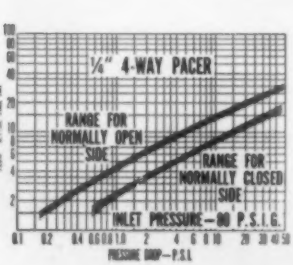
More speed
More capacity
More value

Now you can have about three times more flow capacity-to-solenoid size than in most competitive valves. Needs just 7 watts of power yet minimum internal orifice size is full $\frac{1}{32}$". The PACER has short poppet travel, will cycle at better than 1000 cpm and meets JIC specifications. Lightweight, cast aluminum body means 3-way weighs just 20 ounces, 4-way just 28. Dust tight, liquid tight, can be manually actuated, has captive cover, is inoperative with cover removed, has integral wiring space. Why not test a PACER in your own circuit, just $18 for a 3-way, $26 for a PACER 4-way. Call your Ross representative or write for Bulletin 319.

Pressure drop thru 3-way N.C. Pacer valve under steady flow conditions. Inlet pressure 80 psig. Data shown as a range rather than as absolute values due to variables such as barometric pressure, manufacturing tolerances, etc.

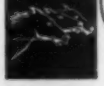


Pressure drop thru both N.C. & N.O. sides of 4-way Pacer valve under steady flow conditions. Inlet pressure 80 psig. Data shows ranges for each side rather than absolute values due to variables such as barometric pressure, manufacturing tolerances, etc.



STAY AHEAD

MODERNIZE



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PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

May 30, 1960 Vol. 31, No. 22

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GASKET EXTRUSION

When gaskets extrude, serious loss of bolt torque often follows. Research indicates that several factors are involved . . . and shows how many extrusion problems can be avoided.

E. M. SMOLEY
Research Physicist
Armstrong Research and Development Center

Flange pressure . . . temperature . . . the kind of gasket and its thickness . . . all are factors in the complex problem of gasket extrusion and torque loss. At times, aluminum flanges are an additional factor that must be considered.

Studies made at the Armstrong Research and Development Center have made it possible to estimate the effect of these various factors. As a result, suggestions can now be made that will help to clear up many extrusion problems.

Gasket material

Certain types of resilient materials will extrude more than others. Straight rubber, for example, is incompressible. If it is deflected beyond its recommended range (about 20%) it will simply flow out of the flange. To a lesser extent, this is true also of the less "corky" cork and rubber gaskets.

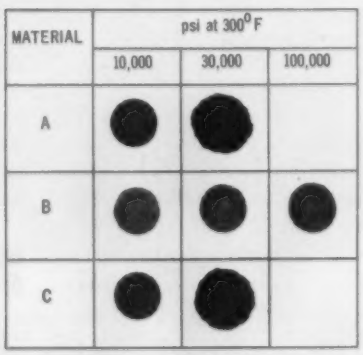

Figure 1. Test samples of conventional fiber materials (A and C) show extensive crushing at 30,000 psi. Accopac AN-890 (B) is not affected at 100,000 psi.

Fiber materials have the least tendency to extrude, but they will often give difficulty where heat and high flange pressure are encountered. The reason is that high temperatures tend to soften conventional fiber materials, allowing the gasket to flow and causing loss of bolt torque.

This can be avoided by using a dense beater-saturated asbestos stock such as Accopac AN-890. The photo at left demonstrates the unusual resistance to extrusion and crushing of AN-890.

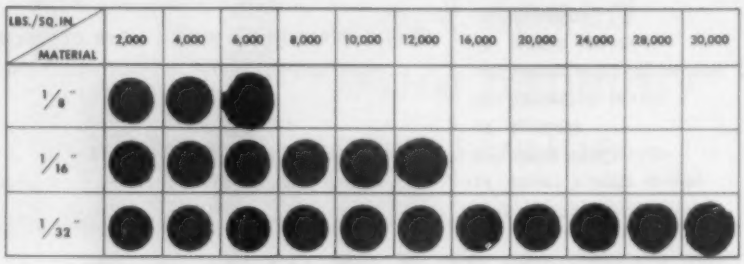

Figure 2. Results of hot extrusion test on cork-and-rubber gasket material. Tests were conducted at 200° F., with thickness the only difference between samples.

Gasket thickness

Generally, the thicker a gasket is, the greater is its tendency to extrude. This is shown in the above photo. Note that a 1/32″ thick material has five times the crush resistance of the 1/8″ sample.

Fiber gaskets exhibit this same tendency to extrude at thicker gauges. In a test involving gauges of .015″, .030″, .065″, and .100″, the thinnest materials exhibited a torque loss of only .5% as against a loss of 76.5% for the thickest sample.

Aluminum flanges

The wide use of aluminum has increased problems of gasket extrusion. This is partly because high temperatures and high flange pressures are usually involved. But aluminum's coefficient of expansion — roughly twice that of cast iron or steel — adds another factor.

As flanges heat up to 300° F. or higher, the expansion of the aluminum flange substantially increases the unit load on the gasket. This increased load can cause extrusion of conventional fiber materials that might give acceptable service with cast iron flanges.

Where aluminum flanges are used, Accopac AN-890 is the recommended gasket material. This dense asbestos composition is being used in many critical applications involving high temperatures and high flange loads.

Detailed information on the selection, design, and performance of resilient gasket materials is contained in the Armstrong Gasket Design Manual. Write for your copy of this 32-page book today. Address Armstrong Cork Company, Industrial Division, 7105 Irvin Street, Lancaster, Pennsylvania.

Armstrong GASKET MATERIALS
1860–1960 Beginning our second century of progress

INTERESTING TO NOTE

On our cover–a "Franckenstein" Measuring Projector, named for its developer, Jack Franck, an electrical engineer at the Univ of California. It measures the paths taken by atomic particles fired by a nuclear accelerator into a bubble chamber and assists in analyzing bubble-chamber photographs by obtaining X, Y, and Z coordinates with a high degree of accuracy and speed. Previously, it took two technicians a day and a half to process a single picture. With the aid of Franckenstein the job can now be accomplished in under thirty minutes.

A bubble-chamber photo is projected onto the screen. An operator then aligns a projected reference mark on the screen with the line to be followed on the film. The machine then maneuvers along the line, not deviating more than two microns, punching coordinates on IBM cards. Information from the cards is then fed into an IBM 650 for a full analysis. A more complete description of Franckenstein may be found on page 54.

One of the earliest ancestors of this expensive scientific apparatus was a crude box with a pinhole on the side, devised by Ernest Rutherford. In 1894, Rutherford, a student at New Zealand Univ, won a scholarship to study at Cambridge Univ in England under the scientist J. J. Thompson. There, Rutherford worked out the complicated changes through which uranium passes as it turns into radium, and then into lead.

Atomic physics was in its infancy and young physicists in the early 1900s were interested in pursuing the new field. The study of the nucleus was less fashionable, but Rutherford felt it was in this area that the secrets of matter and atomic energy could be found. He began his studies by observing the effects of rays emitted from radioactive metals on various gases. He placed radioactive material in the pin-holed box, then backed the box down the length of a gas-filled cylinder. A metal leaf formed a window at one end of the gas chamber and a fluorescent screen was placed outside the window behind the leaf. A pinpoint of

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light appeared on the screen every time it was struck by a radioactive particle. By moving the box through the gas until no light appeared on the fluorescent screen, Rutherford could measure the "range" of the particles of a particular gas.

When nitrogen was placed in the chamber the range of particles was so much out of line compared to results of other gases, Rutherford thought he had made an error in his testing. Upon rechecking, he found that the screen was being bombarded by protons, until then not known to exist. Rutherford discovered that when alpha particles collide with a nitrogen nucleus, a new unstable nucleus is created that disintegrates into a form of oxygen and hydrogen. The fluorescent screen had reacted to high-speed protons (hydrogen nuclei). Rutherford had done two things. His was the first man-made nuclear transmutation and he had proved wrong those who believed that the atom was the smallest form of matter.

Those Unwanted Byproducts

Finding applications for the byproduct of an industrial process is often a difficult problem. For example, there's a fortune to be made by the man who can develop a successful application for the tons of slag produced by steel mills. Chemical companies also are faced with the disposition of various byproducts. About 160 years ago, Galvani and Volta used waste metallic shavings, swept from the floor of a nearby machine shop, to remove rust and varnish from their laboratory equipment. To the machinist, these shavings were useless; today a million-dollar industry is built upon metal shavings or "steel wool." For years nothing was done to market the metal shavings. In fact, their application as a cleaner never advanced past the laboratory stage.

Toward the close of the 19th century, a German, George Schaefer, patented a shaving-block machine designed specifically to manufacture metal fibers (see article, page 57). Industry used steel wool (principally for deburring) for many years before the housewife brought it into the kitchen. Relatively very few firms are engaged in its manufacture, and the industry is highly competitive. In fact, some firms prefer not to rely on patent protection at all. They develop machines secretly, then carefully guard the manufacturing process themselves. —Benedict A. Leerburger Jr

SIDELIGHTS

We read the following note in *Printers' Ink* whose original source was the Washington *Post*. We'd just as soon not know where *they* got it. It seems British European Airways was in trouble. The chocolate marshmallow cookies served to the passengers made something of a mess when they exploded at altitudes over 5000 feet. BEA apparently did some basic research and announced: "A marshmallow biscuit has been devised with a porous base, which enables interior and exterior pressures to equalize and so prevents chocolate fatigue on the outer skin." Next problem.

NEXT WEEK IN PRODUCT ENGINEERING

. . . **Positive-displacement Pumps**
Charts quickly give values for power, efficiency and suction. Also, comparison with other basic types.

. . . **How to Specify Finishes for Magnesium**
A selection guide to the most suitable finish system, including chemical treatments and organic coatings for best properties at lowest cost.

. . . **Custom Knobs Molded from off-the-shelf Tooling.**
Plastic knobs, custom-styled to your specification, needn't carry a custom-price tag.

. . . **Indoctrinating Fledgling Engineers**
When a plant closed for its summer vacation, newly hired engineering grads had a chance to learn company aims and procedures.

. . . **Reinforcing Rings on Pressure Cylinders**
How to calculate their effects upon stresses.

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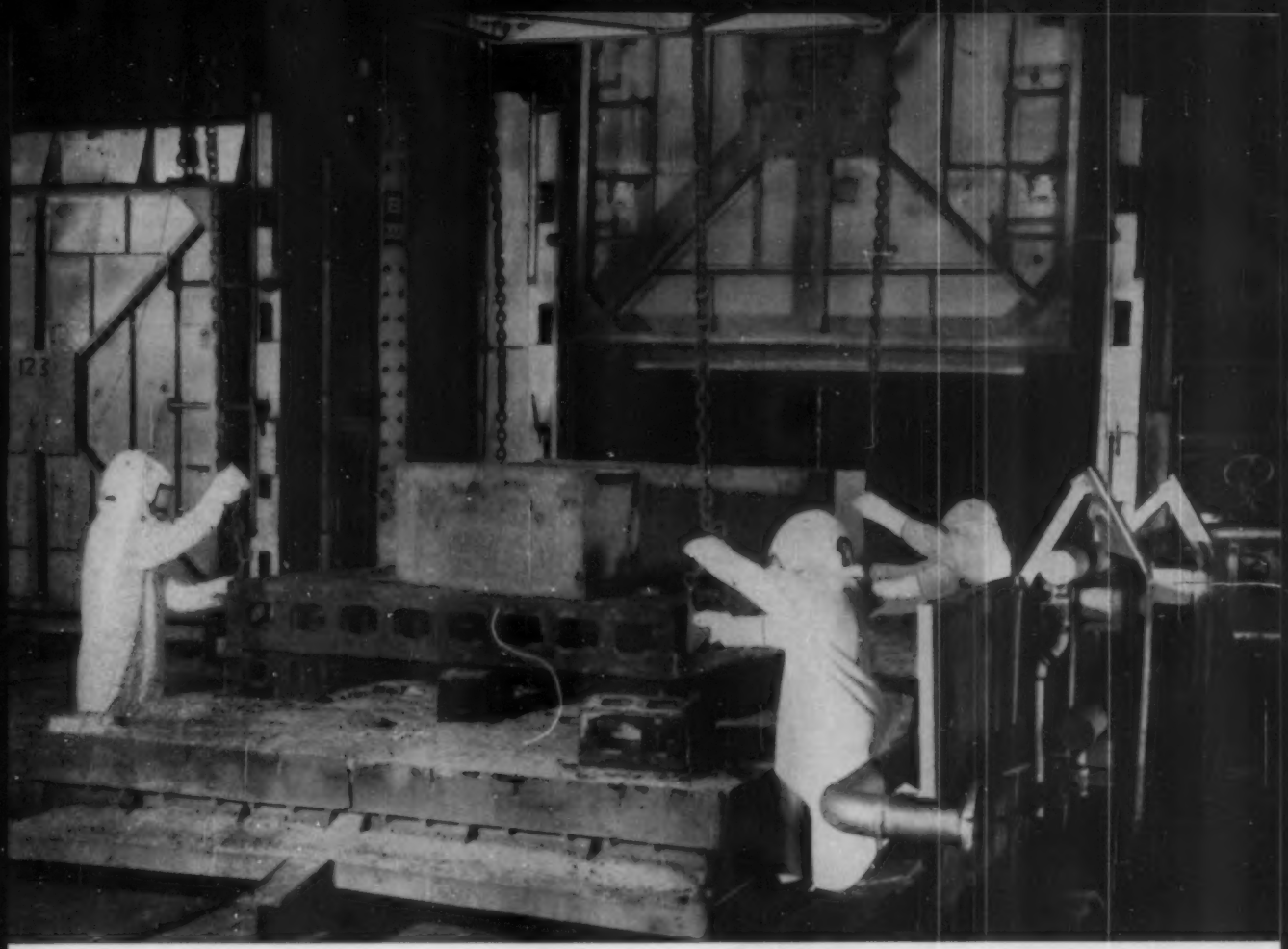

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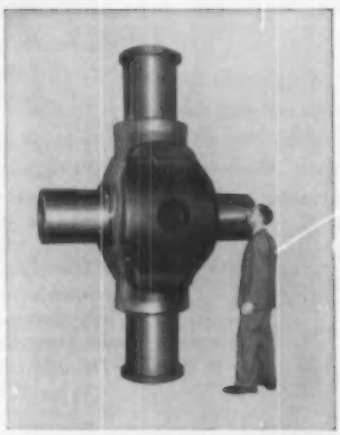
Quench tanks as large as 21 feet × 12 feet and 8 feet deep are available, and all Blaw-Knox Steel Foundries are equipped for spray quenching in which specific areas of steel castings are given special quenching. Further flame hardening or other hardening procedures are provided to meet your exact requirements.

Complete heat treating, quenching, and hardening is another way in which Blaw-Knox Steel Casting Service adds value to your product. Blaw-Knox, as one of the world's leading rolling mill and industrial machinery builders, keeps a sharp eye on the end-use requirements of a casting from start to finish. It's your assurance of a component of the highest quality, made for maximum service.

If you design or build products using cast steel components, ranging from 50 pounds to 300,000 pounds, Blaw-Knox would like you to have a copy of our brochure detailing Blaw-Knox Steel Castings Service. Write to the Foundry and Mill Machinery Division, 300 Sixth Avenue, Pittsburgh 22, Pennsylvania. No obligation of course.



This main axle casting for the 60-cubic yard Mountaineer Shovel was cast in a Blaw-Knox Steel Foundry. Wt.—18,000 lbs.

BLAW-KNOX

Steel Castings

DEVELOPMENTS TO WATCH . . .

Blends help synthetic rubber resist ozone

Oil and fuel-resistant compounds, with excellent ozone resistance—for cable jackets, conveyor coverings, and the like—can be obtained by blending nitrite (NBR) synthetic rubbers with polyvinyl chloride (PVC) resins, says W. A. Wilson of Goodyear.

But the processing method must be carefully controlled; and considerably better results are achieved with high-acrylonitrile rubbers than with those of lower content. Also, it's best that the PVC resins be of relatively high molecular weight. Fillers and pigments, too, may alter the ozone resistance of the finished product.

Springback still plagues titanium users

Though titanium mills are now meeting thickness specifications on sheets as-delivered, and variation in tensile properties is held within respectable limits, there are still problems—and many of them—in obtaining finished parts that meet similar standards.

That's the gist of a report from Defense Metals Information Center. The key problem lies in forming properties of the metal itself, and particularly in its uneven springback. Says DMIC:

Springback of parts formed in punch presses, or with rubber pads, ranges from 9 to 40°.

This means aging treatments ordinarily applied after forming have to be carried out in jigs, or the alloys have to be formed in heated tools.

Creep-forming processes and other methods combining forming and aging treatments are receiving considerable attention. But it is difficult to maintain dimensions while hot-forming—without destroying, by overaging, the properties obtained previously by heat treatment.

Titanium is not the only metal that suffers from springback, though. Discussing high-strength steels, DMIC says:

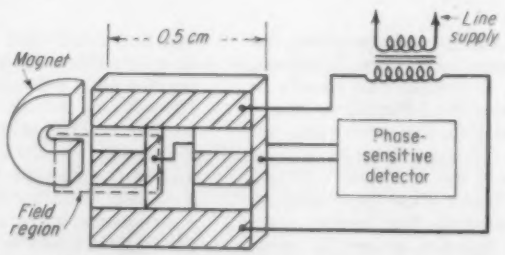
In the soft condition, the martensitic types can be stretch-formed and brake-formed, but springback is a serious problem in forming stronger sheet.

Springback is one of the problems, incidentally, that has spurred interest in explosive forming and related techniques since they tend to suppress or overcome it.

British develop semiconductor comparator

A magneto-resistance comparator, said to be sensitive to displacements of 1 angstrom, has been developed in Britain by National Research Development Corp.

The sensing element is a rectangle of indium antimonide with a hole in the center. Four contacts are soldered to it to produce what is essentially a Wheatstone bridge. A miniature permanent magnet with soft-iron pole pieces is arranged to move along one side of the rectangle. The magnetic field increases the electrical resistance of the indium antimonide.



SEMICONDUCTOR MICROMETER measures displacement by means of changes in resistance that occur as magnet is moved.

When the magnet is placed on the center, it increases the resistances of both arms of the bridge equally, and the bridge is in balance. When the magnet moves in either direction, it unbalances the bridge and produces a voltage signal.

In the unit employed as a displacement detector, a bridge current of 250 ma gives a sensitivity of about 1 mv per 0.001 in., which can give full-scale deflection on a meter.

Indications are said to be linear over a range of 0.01 in.; temperature error is less than 1% per °C.

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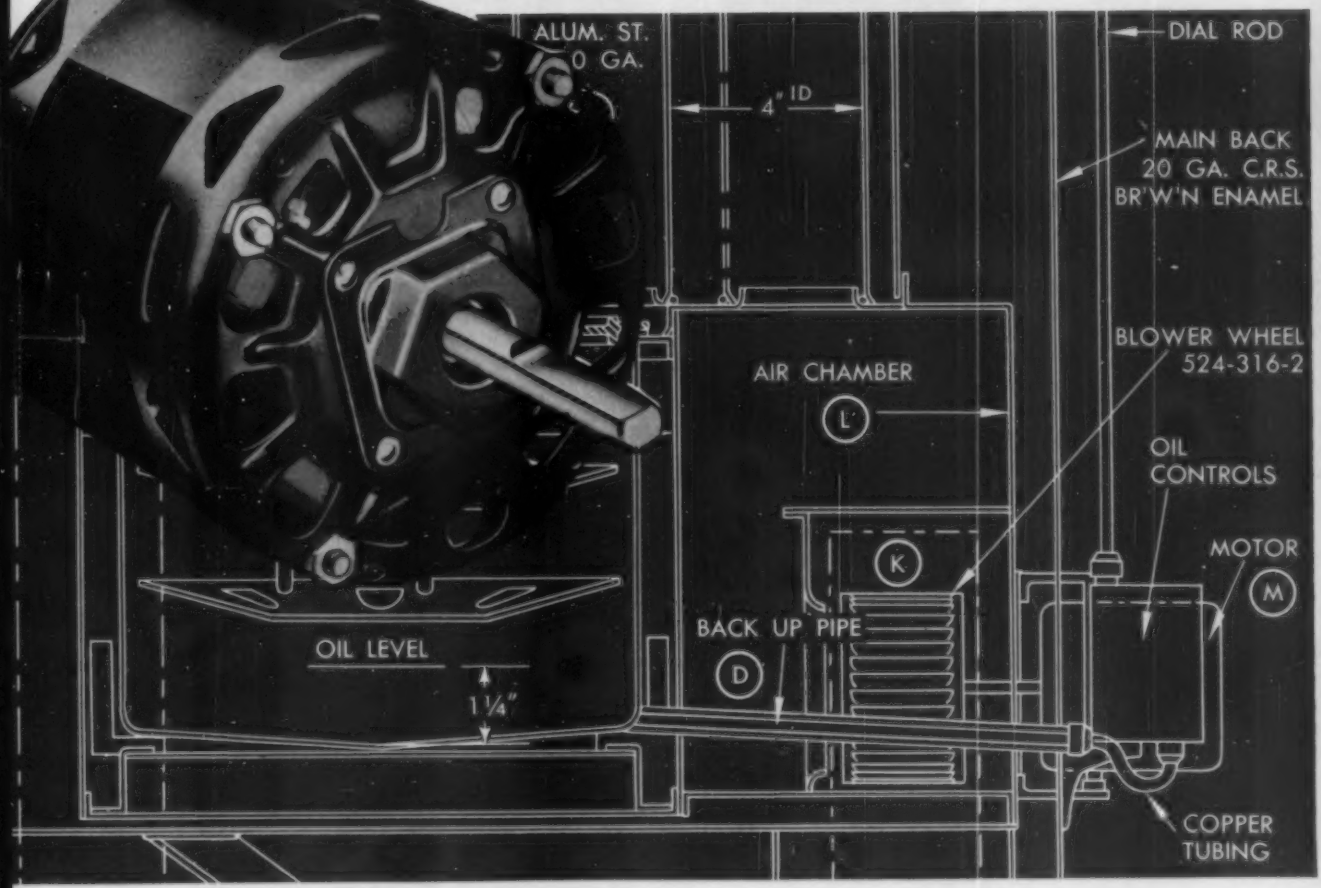
NEW Redmond TYPE AO FITS YOUR PLANS



This new small diameter MicroMotor combines low cost and high power. The Type AO is a quality, whisper-quiet, dependable motor that has high performance characteristics formerly available only in large diameter motors. Designed to be ideal for a multitude of applications in the heating, air conditioning, ventilating, refrigeration, and appliance industries, the AO is available from 1/8th through 1/50th horsepower, in 4-pole and 6-pole design. Companion single or double blowers deliver up to 800 CFM.

Redmond Sales Engineers want to work with you to adapt this new motor to your needs. Contact us at Owosso, Michigan, and we will have your local Redmond engineer call on you.

NEW CATALOG—New 12-page catalog describes and illustrates basic line of Redmond fractional horsepower electric motors, blowers, and special products. Send request for your free copy to Redmond Company, Inc., Owosso, Michigan.

The Standard of Dependability

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THE BIG NAME IN SMALL MOTORS

New plastics offer better thermal and optical qualities

Three transparent plastics are to be introduced by Polycast Corp this year. One, claimed to have an "extremely high" heat-distortion temperature, is being developed for such applications as supersonic aircraft canopies. Another is an improved crystal sheet stock for sight glasses and watch crystals. The third is a development which, Polycast predicts, will make possible "the first commercially practical large-volume line of plastic ophthalmic lenses." Also promised for 1960: new flame-retardant sheets for light panels and similar applications.

More polyethylene and new copolymers coming

Easier-to-process polyethylene plastics that offer improved rigidity, heat resistance and crack resistance are promised by Foster Grant Co as it prepares to enter this growing field. A new plant, now being designed for FG, will use a new high-pressure polymerization technique and will produce not only the basic resin but also a wide range of copolymers with such related materials as propylene and butylene. Target date for completion of the plant has not yet been announced; but it should be within a year.

Simplicity featured in new lens design

Two elements, one spherical and one concave, take the place of ten in a new f/0.8 optical lens designed in Japan. The lens is said to be readily adaptable to mass production.

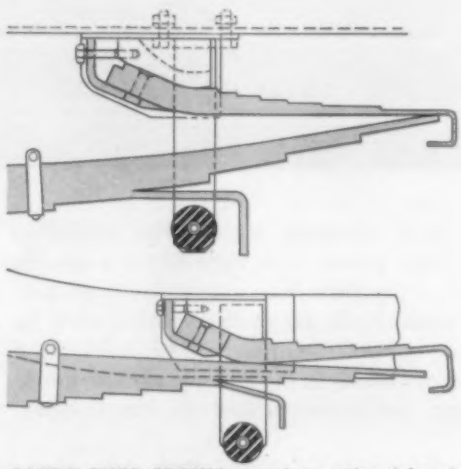
Secret of its success, according to its inventor, Prof Shotaro Yoshida of Tohoku Univ, Sendai, Japan, lies in selection of the glass itself. The spherical lens is made of a special, low-aberration type containing the rare-earth element lanthanum (*PE—Apr 25, p 39*); the concave element is flint glass.

British develop new laminated spring

The old leaf spring is taking on new efficiency in Britain with the aid of an auxiliary unit that helps compensate for the large difference between loaded and unloaded weight of many present-day vehicles. Fixed-rate springs must be designed for maximum load, resulting in little deflection and a rough ride when the vehicle is light.

The novel feature of the new design is a cantilever-type support spring that is provided for the rear end of the main spring. Its purpose: to increase the deflection of the main spring at low load.

The cantilever itself is very flexible and responds readily to light loads. It is so arranged that it touches the main spring only at the tip (see diagram) and goes out of action when the vehicle is fully loaded. The main spring is then supported by the part of the cantilever that is secured in its shoe, and it becomes, in effect, a standard suspension. An additional feature of the new design is a rubber bushing mounted in the support shoe. It prevents rebound by maintaining contact between main spring and cantilever when the vehicle is light, but permits them to separate when the load is applied. W E Cary Ltd, Red Bank, Manchester 4, is the manufacturer. —ARG



CANTILEVER SPRING goes into action (above) when vehicle is light; main spring takes over when vehicle is loaded (below). The way, it provides better cushioning under light loads, while maintaining normal support under heavy loads.

WHAT'S HAPPENING IN RESEARCH . . .

Making semiconductors help themselves

By taking advantage of one of the special electrical effects that can be produced in semiconductors, Nuclear Corp of America is finding ways to improve the semiconductors themselves. Concerned here is the Peltier effect (if current is passed between two dissimilar metals—or junctions of a semiconductor—heat will be evolved at one junction and absorbed at the other).

Under WADC contract, NCA's Research Chemicals Div is attempting to utilize this effect for controlling crystallization of semiconductor materials. Research is still in its early stages; but NCA says work with germanium indicates that the process is feasible.

Study uncovers the most stable steels

When extreme dimensional stability is required, try annealed 410 stainless, nitrided to a depth of 0.009 in., ground, stress-relieved, and lapped—and if a frosting appears, don't mind it.

That's the gist of a report from National Bureau of Standards on a study of 16 materials that might be used to produce better gage blocks.

The frosting? It's the typical gray-coated appearance of nitrided surfaces that have not been ground and lapped. But, says NBS, its possible appearance on worked material does not lessen stability and it is easily removed by further grinding.

Although the nitrided 410 materials came out best in the tests, through-hardened 52100 steel blocks showed good stability, particularly after 6 months' aging.

Other materials tested included 309, 405, 420, and 17-4 PH stainless; D2 and modified T15 tool steel; titanium carbide; and aluminum oxide.

The noble metals readied for new jobs

Gold and platinum are becoming the every-day materials of electrical, electronic, and nuclear engineers.

As silicon transistors gain prominence, for instance (*PE*—Mar 28, p 8), the demand for high-purity gold foil grows. It's one of the few materials that will "wet" silicon and can be used for attaching leads to silicon wafers. In nuclear engineering, gold has already proved its ability to withstand the corrosive attack of such liquid "fuels" as uranyl phosphate.

A report relayed by J Bishop & Co notes the development of platinum-film fixed ceramic resistors for 930-F operation. These can be made in at least three ways: by "printing" and baking platinum or platinum-gold alloy films on glass substrates, by forming and fixing metalized glass fibers in the desired pattern, or by evaporating platinum or palladium films on a ceramic base.

Ultrathin platinum foils are also being developed to serve as gap foils in recording circuits; there is special low-restivity gold alloy wire for use in potentiometers; and vapor-deposited gold is providing special optical qualities like infrared absorption (*PE*—Aug 10 '59, p 13).

Metals and chemicals sound off

A crystalline compound that clicks its way—audibly—through transitions and metals that squeak under stress may provide new clues to chemical reactions and mechanical stress.

The compound is a mixture of cesium and rubidium chlorides. It takes the form of a translucent crystal when it is first formed from the melt; but, on cooling, changes suddenly to a white, opaque mass. This sudden change, St. Louis Univ researchers report, is accompanied by an audible click. The click apparently signals an "unmixing" of the material, and may provide a means for measuring and monitoring such changes even when there are no visible indications.

The fact that a few metals, notably tins, can produce audible sounds when stressed has long been known; but it is only recently that an attempt has been made to discover the extent of this phenomenon and put it to work.

In tin, the phenomenon has long been associated with a "twinning" process which occurs in the crystalline structure of tin when it is deformed. One problem was whether acoustic emission occurred in metals that were not known to twin, and whether this indicated an unsuspected twinning process or whether other factors might be responsible.

Under Air Force contract, Lessells and Associates has been investigating this question. A preliminary report, (WADC Technical Report 58-194; ASTIA Document 155, 674), prepared about two years ago, indicated that audible signals are generated within the structure of a good many metals, and that factors other than twinning might be responsible.

Now, B. H. Schofield, senior project engineer at Lessells, reports that further studies indicate the phenomenon can indeed be traced to micro-mechanical deformation occurring within these metals (aluminum, for instance), and may be a source of important information on mechanical deformation and failure.

Work is continuing, with studies planned to cover the effects of temperature, neutron irradiation, and magnetic fields on the emission phenomenon, and to investigate other physical parameters.

briefs . . .

Technical photography, and the special films and plates available for scientific and engineering use, get special attention in a new 40-page Kodak booklet (P-9). Price: 50¢.

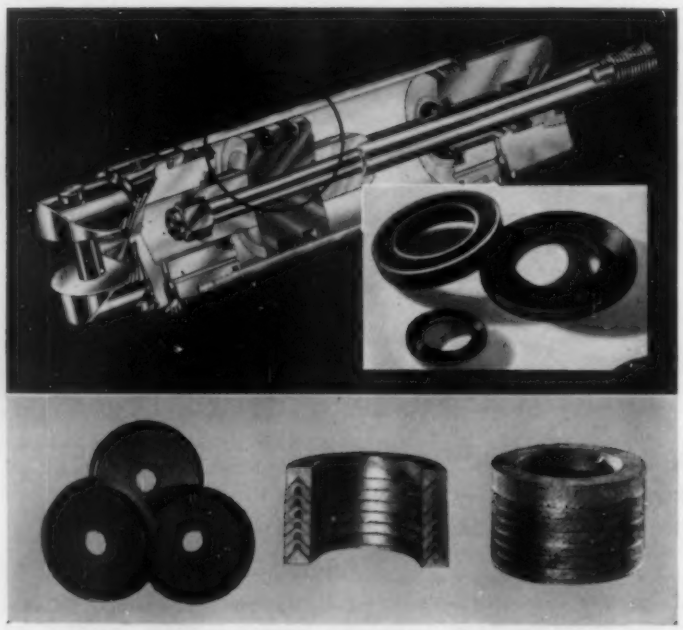
Periodic chart of the atoms, printed in big, clear letters, gives atom names, numbers, symbols, plus an unusual and valuable "extra"—price/lb for each element in commercially pure form. (Cheapest: carbon, 5¢; most costly: radon, $900,000/lb, and radium, $8 million—but some of the "new" elements are so rare and costly no price can be given.

The chart is wall size (17x20 in.); but folds to pocket size. It also contains basic nuclear data; but omits technical details often confusing to those who are not nuclear specialists. Single copies are free from Atomic Development Mutual Fund, 1033 30th St NW, Washington 7, DC.

—ARG

ENGINEERED PRODUCTS

for Hydraulic, Pneumatic Service



Garlock "U" Cup and "V" Ring Packings (top) provide tight sealing, help increase efficiency of famous Tomkins-Johnson "Spacemaker" cylinders. Garlock molded cups (bottom left) and CHEVRON* Packings are also specified for air and hydraulic cylinders.

Tomkins-Johnson standardizes on Garlock "U" Cup and "V" Ring Packings for their famous "Spacemaker" air and hydraulic cylinders.

On a wide variety of "Spacemaker" applications, Garlock packings provide leak-proof service against air, water, and hydraulic fluids at temperatures to 250°F, pressures to 1000 p.s.i. Tomkins-Johnson specifies Garlock products because of their greater flexibility, minimum friction, and resistance to sudden shock loads.

Garlock "U" Cup Packings are specially designed for proper fit against the cylinder wall—this prolongs service life to a maximum. Available in several materials and designed to JIC standards, the cups are applied on diameters ranging from 1″ through 14″. Flexible and resilient Garlock "V" Ring Packings respond quickly to low gland and fluid pressures, offer positive, low friction sealing at all pressures. Available in various materials and sizes.

Enjoy the same advantages that Tomkins-Johnson does—standardize on Garlock hydraulic-pneumatic packings. Garlock's complete line also includes widely-used CHEVRON* Packings with an exclusive hinge-like construction that "rides" with the pressure . . . tightens as pressures increase, eases off as they decline . . . results in positive sealing with little friction. Garlock Molded Cups provide maximum efficiency in sealing air and hydraulic cylinders over a wide range of service conditions.

For more information, call your local Garlock representative at the nearest of our 26 sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalogs AD-163 ("U" Cup Packings) and AD-115 (CHEVRON Packings). Garlock Inc., Palmyra, New York.

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Canadian Div.: Garlock of Canada Ltd.

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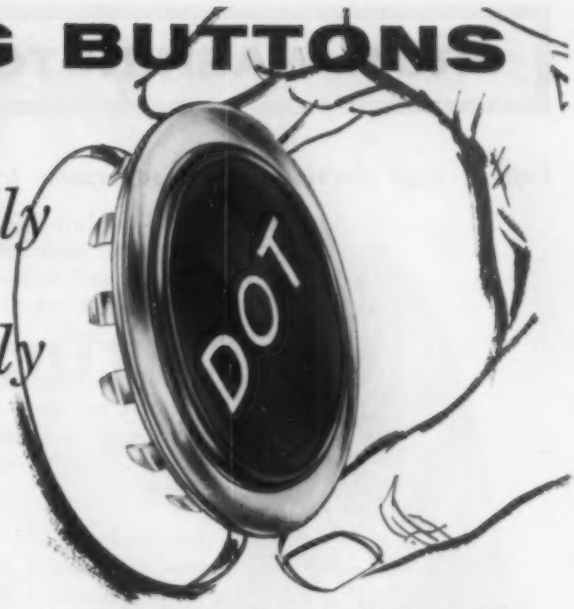
DOT PLUG BUTTONS

fill holes functionally and decoratively



Inexpensive DOT Plug Buttons are ideal for covering drilled or molded holes in metal or plastic structures of all types. Finger pressure snaps them into place, spring tension holds them there without rattling even under conditions of severe vibration.

Used as covers for inspection or maintenance-access holes, Plug Buttons are easily removed and can be re-inserted repeatedly without lessening their effectiveness. Used in combination with plastic lens inserts, Plug Buttons make excellent indicator-light covers. Faceted, Fresnel-type or plain lenses can be made in a variety of colors and can be designed to show words, letters or symbols, according to the requirements of the particular application.

DESIGN ENGINEERING SERVICE

Designers, metallurgists and plastics specialists on DOT's engineering staff are equipped to work out optimum combinations of metal and plastics to suit your particular requirements. Hundreds of variations in shape, finish and material are possible.

The basic steel or brass Plug Button, for example, can be parkerized or polished or finished in chrome, nickel, zinc, copper or any of a wide variety of colored enamels. Designs can be stamped into the metal or molded Lucite lenses can be inserted.

Nylon, polystyrene or flexible polyethylene Plug Buttons can be molded to show trademarks, indicator symbols or any other design.

For [illegible] write for Engineering Data Catalog, Section D

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FROM WASHINGTON . . .

Experts urge development of supersonic transport

The US can have 2000-mph passenger planes operating in the next 8 to 10 years. That is what government and industry aircraft experts told the House Committee on Science and Astronautics. The experts said a development program for such planes must be started soon or such competitors as Russia and England are likely to take the lead.

A protoype plane could be flying within 3 to 5 years at a cost of about $1 billion. Representatives from the National Aeronautics and Space Administration, the Federal Aviation Agency, the Air Force, and engine and airframe builders all agree that the US has the capability to build such an aircraft now, if money is made available.

Patterned generally after the Air Force's B-70 bomber, the transport would require some radical designs. To meet commercial operating requirements, the plane would need a design that provides a large wing spread for takeoffs and landings, but allows the wings to swing back and hug the fuselage once it reached supersonic speed.

Limitations of aluminum are reason for leapfrogging up to Mach 3 speed. Ira H. Abbott, director of advanced research programs for NASA, told the congressional committee that such a transport should fly at 70,000-ft altitudes. Structural temperatures reach 300 F at Mach 2.5, Abbott said, which is about the limit for aluminum construction. At Mach 3 (2000 mph) the temperature climbs to 400 F, and requires such materials as stainless steel or titanium.

By starting at Mach 3 for the supersonic transport, the speeds could be increased to over 3000 mph with minor design changes. This would insure that the aircraft would not become obsolete, or surpassed by other countries at an early date, the expert predicted.

Noise reduction and cabin pressurizing are two big problems. The noise factor could be reduced by going to turbofan engines to power the plane, but this, in turn, would call for development of a new engine. **Cabin pressures would have to be 100% efficient, too, the committee was told.** A loss of pressure while flying at 70,000 ft would mean death of all passengers, the experts pointed out.

An operating fleet of supersonic jet transports would not make existing terminal facilities obsolete, the experts said. The biggest impact would come in traffic-control procedures. The big planes would have to get priority on landing. They could not be held aloft around airports as conventional planes are while waiting their turn to land. Once the high-speed plane dropped to subsonic speed, it would have to land, as it would have insufficient fuel left to return to supersonic speed, the committee was told.

These supersonic planes would be best suited to use on international routes or between points that are at least 2000 mi apart. But under these conditions, the congressional committee was told, operating costs would be about the same as for present jet transports.

The Air Force told the legislators that it "stands ready to serve in executive management" of the jet-transport project. But the service made it clear that financing would have to come from other places than the Air Force budget. A joint venture among the military, NASA, FAA and industry is the ideal way to handle the program, the committee was told.

FISHING

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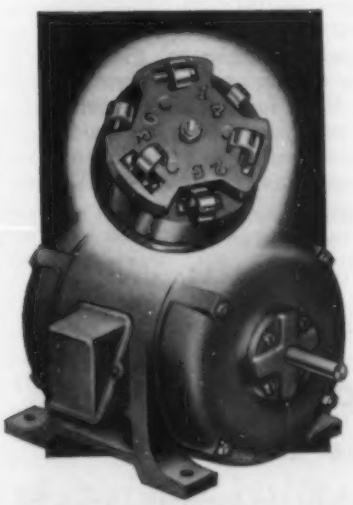

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Motor burnouts are always a problem. They slow production, idle workers (except the repair crew) and are costly.

You can practically eliminate motor burnouts in your equipment and replacement motors by using motors with KLIXON Protectors.

Built-in by the motor manufacturers, KLIXON Protectors safeguard and protect motors from burning out under the following conditions . . . prolonged overloads, unbalanced voltage, stalling, failure to start, increased ambient temperatures, lack of ventilation, plugging, or reversing duty, and single phasing.

And remember, get the same complete protection in your single phase motors, too.

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THE ENGINEERING WEEK

Hannover—Europe's Number 1 Fair?

Bigger and better than ever, the 1960 German Industries Fair ranged from small household gadgets through industrial machines and equipment, to complete processing plants and immense oil-drilling rigs. This first-hand account comes from McGraw-Hill's World News Bureau at Bonn.

HANNOVER, GERMANY — Although many industrial groups no longer participate here, preferring to stage their own biannual or triannual exhibits, some 4791 exhibitors (168 more than in 1959) from 25 countries occupied 5 million sq ft of space to make this year's annual Fair the biggest ever. Many in the show still feel the Fair should be a biannual affair—leaving more time for development work and allowing the extra money to be poured back into constructive research. But despite these rumblings, American participation appears enthusiastic and on the increase.

Six of the 91 US exhibitors were new to Hannover; these included Fairchild Camera and Instrument Corp, Yonkers, NY, whose European manager, Hal W. Melahn, said he hoped his firm would take a 5-year lease on exhibit space here. In addition, Gilbert MacKay of New York City led a group of 95 American businessmen and spent three days at the Fair. Members of the group agreed that they were impressed with quality of products shown, the variety and methods of presentation.

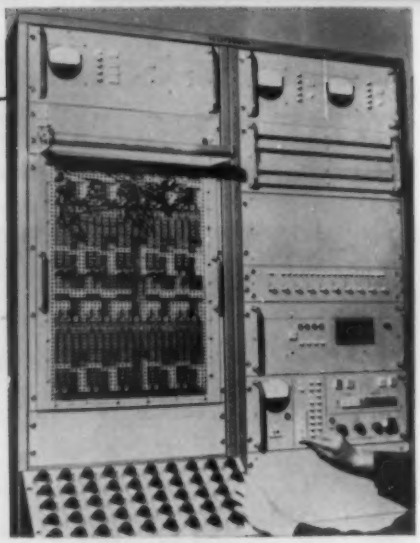
This enthusiastic reaction was for the wide range of products—tiny household gadgets to huge industrial machines. Although manufacturers of machine tools now save their product unveilings for other expositions, considerable industrial machinery—woodworking machinery, in particular—was shown at Hannover. These exhibits indicated new trends in materials, drive assemblies, design and controls, which may soon spread to metalworking equipment. Despite their offering machines which are designed for special rather than standard applications, most manufacturers made available standard components which are interchangeable even among different makes.

A significant trend was the location of essential controls convenient to the operator's hand and the installation of infrequently used controls on a separate panel. Some machines even used a joystick assembly to permit movements in two dimensions from a single control lever. In process gaging and inspection, particularly on copying and duplicating machinery, was fully automatic with the result that the machine could check its own operation and correct errors, if necessary.

Until now, little use has been made in Germany of numerical controls as an electronic means of bringing reliable and automatic control within easy reach of the small machine shop. However, a number of the machines on view at Hannover seemed to indicate that some German manufacturers are readying this control technique, and that a number of numerical-controlled machine tools will be unveiled in Germany next year.

Other developments under serious study may lead German machine designers to drop the conventional antifriction and plain bearings in favor of air, gas, or liquid bearings. Many feel these newer bearings will provide the only really satisfactory answer to increasingly higher machine speeds and tougher alloys. Trend in Europe seems to be away from expensive trans-

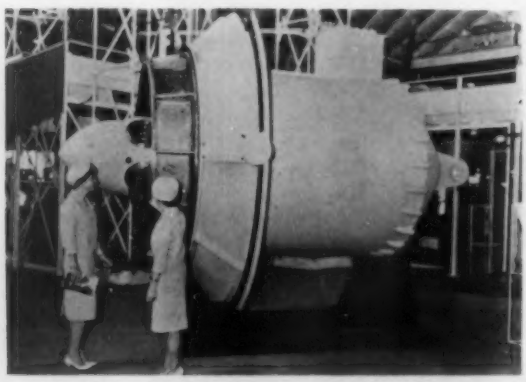
NORTH AMERICAN AVIATION AUTONETICS DIV drew crowds with its Recomp II general-purpose all-transistorized digital computer. Also on view was a pilot's display projector that creates the illusion of three dimensions by using specially coated combiner.



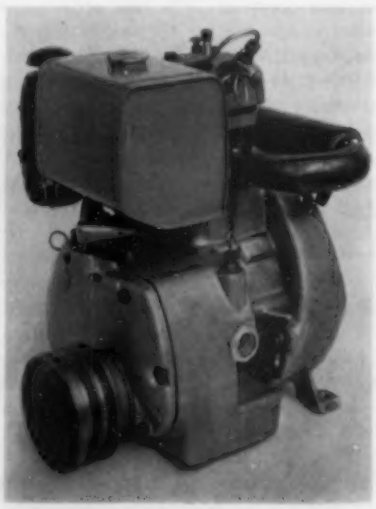
GERMANY'S TELEFUNKEN all-transistorized analog computer also was a crowd drawer. Claimed accuracy is better than 0.1% and Telefunken claims substituting transistors for vacuum tubes reduced size by half, power input by 1/5.

GERMANY'S DINGKERWERKE road finisher incorporates new designs that allow various finishing units used to distribute gravel, ballast or bitumin to be hitched to power unit, trailer-fashion. Conversion from one accessory to another takes only 30 min.

NUERNBERG'S FAUN-WERKE underground mining truck was one of the surprises at the Fair. Obviously destined for the US market (Germany has no drive-in mines), the 7-ton vehicle is purposely throttled to keep carbon monoxide content to less than 0.02% (0.007% is claimed) by volume. It has a 6-speed transmission and two sets of steering gear.



FRANCE'S JEUMONT showed its axial turbogenerator for river and stream power generation. At speed of 136.4 rpm, a research double-wheel model is said to generate 10,000 hp. With a change in water flow direction, the drive wheel is automatically stopped and the other wheel released, permitting continuous generation. Blades are adjustable to flow conditions.



MUNICH'S VOLLNHALS K. G. displayed, for the first time at Hannover, this air-cooled diesel engine claimed to be lightest in the world. The 5-hp midget weighs only 84 lb.

fer machining to the simpler, more flexible automatic loading and unloading of workpieces.

Touring the exposition, the following exhibits emerged as highlights:

• A series of radioactive-source gaging and control instruments for thickness and density measurements on moving or stationary materials and fluids. Exhibited by Frieseke & Hoepfner of Erlangen, the equipment provides for measurements to be taken either by the transmission or the backscatter method of radiation. The measuring unit is fully electronic and readings are recorded continuously on a strip chart. US distributor is Curtiss-Wright Corp.

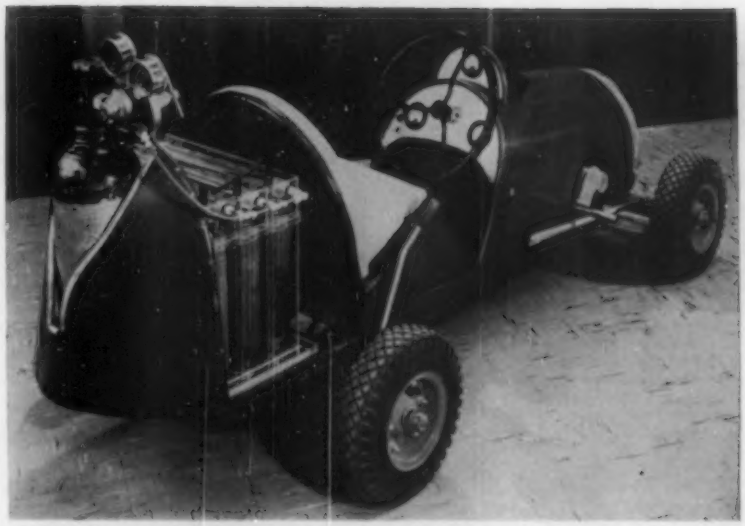
• Europe's first ultrasonic welding unit, made by Lehfeldt & Co of Heppenheim, requires no metal preparation and will joint two unequal thicknesses of the same or different metals. Max thickness of metals is now 0.02 in. but a prototype for 0.04 in. sheets is being built. A variable-speed drive unit propels the metal sheets between vibrating wheels which knead the metals together to a homogeneous joint.

• A small gas turbine, similar in design to the powerplant shown by the Bavarian Motor Works (*PE*—Apr 4, p 21) at last year's show. Weighing only 138 lb, the Deutz unit develops about 90 hp (SAE); is said to start easily even at subarctic temperatures.

• A new process for soldering ceramic-to-metal junctions was exhibited by Cerberus of Switzerland. Though it can be used with all technical ceramics, the new process is primarily suited for difficult-to-solder aluminum oxide ceramics. New process is said to give freedom of junction design and complete absence of thermal tensions. Ceramic metallizing and soldering take place simultaneously. There is complete freedom in selection of materials.

• Siemens of Munich showed its SIMATIC controls for the first time. Features are a complete absence of contacts to give a lifetime of service. Rate of switching is about 10,000 switchings per sec. Standardized parts are used throughout.

• Look also for a new dielectric fluid for spark-discharging machining to replace the conventional but not completely satisfactory kerosene and silicone fluids. —Jim Morrison



EXIDE'S FUEL CELL AND OXYGEN TANK are "luggage" of this small racer. Tank feeds oxygen to cell at low pressure to produce 27 volts (1.5 per cell) and 2 kw max. This prototype vehicle, including 18 fuel cells, weighs 200 lb, needs 50 amps to start. A full scale truck will need 200 amps.

Zinc-type Fuel Cell Nears Application in Industrial Trucks

PHILADELPHIA—Within three years, Exide Industrial Div of Electric Storage Battery Co expects to have a fuel cell of unusually simple design operating in electric industrial trucks. This cell, now past basic- and applied-research stages, uses zinc as fuel and compressed oxygen for oxidizer.

A major advantage of the Exide concept, company sources say, is its doing away with the gaseous fuels present in most other fuel cells. These fuels create water or other waste products that dilute the electrolyte unless drained off—a design problem that has not yet been satisfactorily solved.

In the circular fuel cells developed by Exide, a positive electrode at center is surrounded by negatively charged zinc tubes. An electric current is created when the zinc in a potassium hydroxide electrolyte is oxidized by oxygen admitted under low pressure. The fuel cell is encased in a fiberglass tube with polyvinyl shield.

This cell, according to company sources, operates at normal pressure and temperature, and can be mass-produced easily. The cell has no theoretical size limit, can be designed for a wide range of electrical capacities to fit vehicle power requirements.

It reportedly provides enough power to keep an industrial truck running for 16 to 18 hours without voltage drop. The conventional electric-truck storage battery is good for 8 to 10 hours.

MAINTENANCE COSTS LOW

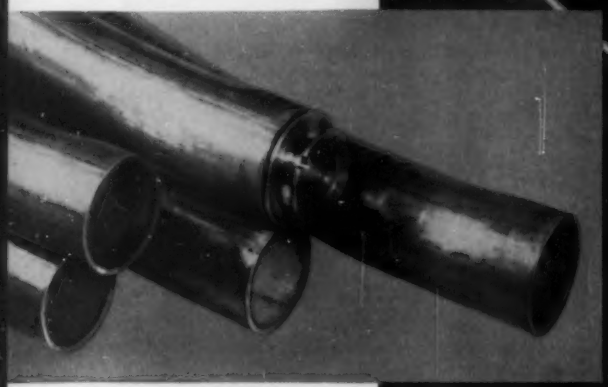
The cell can be recharged either electrically or, if the vehicle must run continuously, by replacing the zinc tubes. Because the zinc oxide formed now commands a higher market price than zinc, Exide believes that it will be able to accept used tubes for credit, thereby considerably reducing maintenance costs. The tubes, connected by mechanical linkages, can be easily extracted from the cell as a single unit.

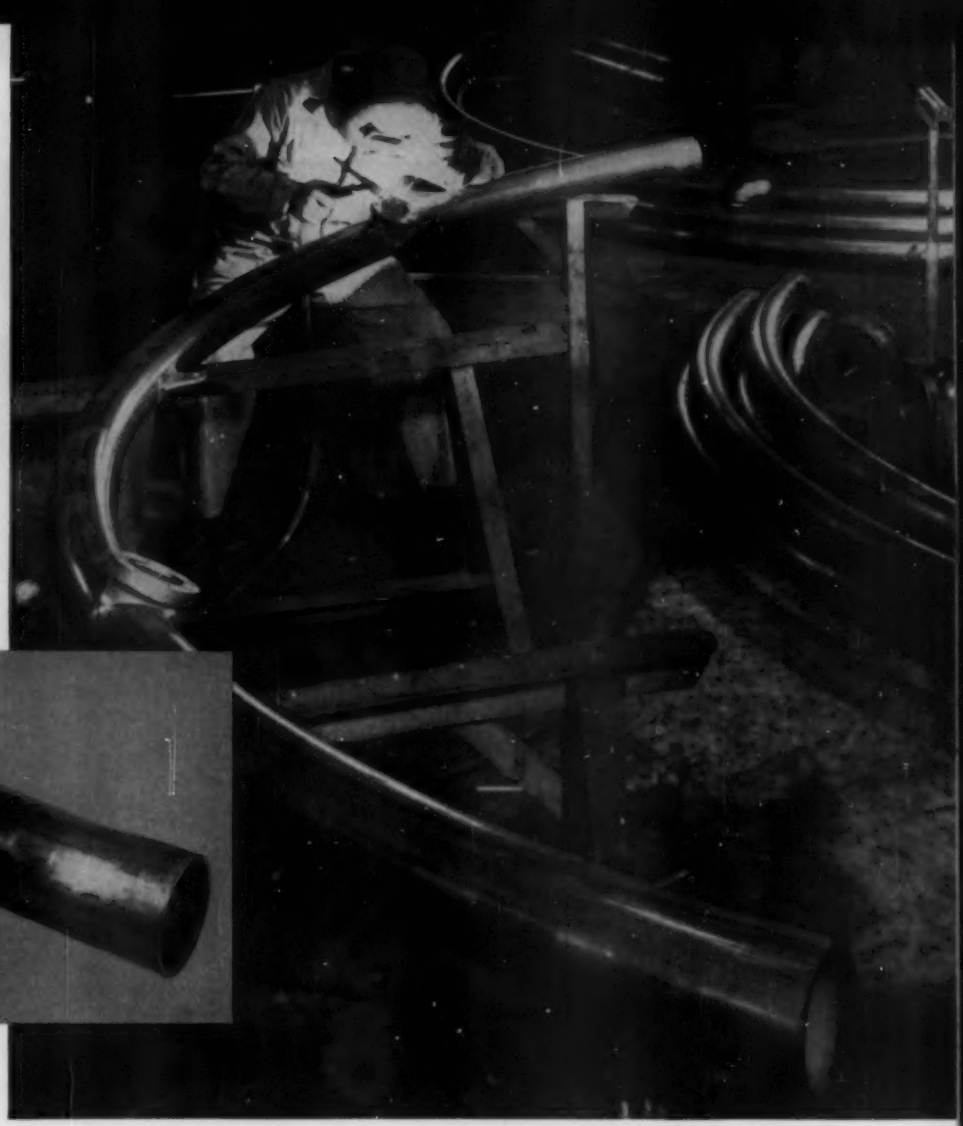
Power efficiency for the cell is said to run about 80%. Exide will not yet release information on weight of the unit or horsepower-to-weight ratios.

Twelve of the nation's leading manufacturers of materials-handling equipment are cooperating in development of this cell. It may be commercially introduced in less than 3 years depending on performance requirements of the equipment manufacturers.

Meanwhile, Exide is working on other fuel-cell concepts. Ultimately, the company expects a variety of applications including taxis, street delivery trucks and buses. ■

Non-Magnetic and salt- corrosion-resistant Republic ELECTRUNITE® Stainless Steel Tubing, Type 304, 4½″ O.D., was used to fabricate corona rings for a powerful East Coast Navy Radio Station. Despite the rather severe bend of the 15- and 20-foot rings, the fabricator reported no trouble whatsoever. The rings were made in three sections. ELECTRUNITE was bent to the correct radius. Three lugs were welded to each section. The ends were flared for the insertion of a plug used at the erection site to assemble the three pieces into a complete ring and suspend it from towers approximately 1,400 feet high. The fabrication was handled by Jetsch & Company, Inc., Buffalo, New York, subcontractors to Lapp Insulator Company, Leroy, New York.





Bend, Flange, Weld, Easy-to-Fabricate ELECTRUNITE STAINLESS STEEL TUBING

ELECTRUNITE Stainless Steel Tubing and Pipe are available in A.I.S.I. crome-nickel analyses. Sizes range for ⅜″ O.D. to 5″ O.D. Pipe sizes are available from ⅛″ I.P.S. through 2″ I.P.S. in ASA schedule 40S; from ⅛″ I.P.S. through 4″ I.P.S in schedule 10S; and from ½″ I.P.S. through 4″ I.P.S. in schedule 5S wall thicknesses.

This fabricator needed a reliable source to supply large diameter heavy wall stainless steel tube for corona rings. From its large size range, Republic was able to provide the proper tube for this vital application.

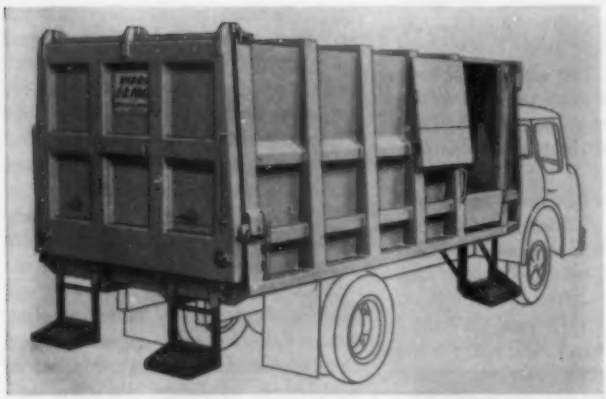
Most experienced welded tube maker, and world leader in the production of stainless and alloy steels, Republic has all the facilities to qualify as your number one source. Complete range of sizes, gages, wall thicknesses. Broad distributor stocks. Large inventories of mill stocks to draw on. Top reputation for quality and for ability to meet deliveries. Technical and metallurgical assistance. Fast service: price and delivery quotations to you within twenty-four hours.

For applications requiring pressure-tested tube, Republic offers exclusive FARROWTEST —the ultimate in non-destructive testing. This eddy-current test probes for and detects defects so minute they pass other, less positive tests. Tube quality is measured for you!

Send in your inquiries for Republic ELECTRUNITE Stainless Steel Tubing and Pipe. You'll like the product . . . and the service.

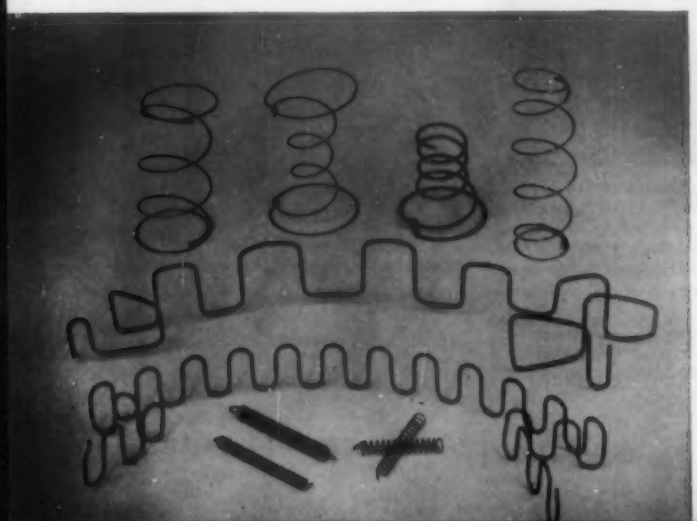
CIRCLE 18 ON READER SERVICE CARD

REPUBLIC NYLOK® STUDS SOLVE FASTENING PROBLEM for Gravely Tractors, Inc., Dunbar, West Virginia. Problem: Find a dependable fastening method for tractor-attached rotary cultivators. Fasteners must withstand constant shocks and pounding of rotary cultivating. Solution: Use Republic NYLOK Studs. A special nylon insert assures positive locking at any position, even under severe shock, vibration, tension. Prevents all play. Utilizes metal-to-metal contact of opposing threads for locking. Republic NYLOK Fasteners —studs, nuts, cap screws—are re-usable. Nylon insert resists heat, cold, moisture. Mail coupon for facts.



REPUBLIC HIGH STRENGTH STEEL SOLVES WEIGHT PROBLEMS in Hydro E-Z Pack enclosed truck bodies, manufactured by Hercules Galion Products, Inc., Galion, Ohio, for haulers of refuse and garbage. Use of Republic "50" High Strength Steel reduces body weight, permits increased payload on smaller chassis, and the hauler makes fewer trips to the dump. Republic "50" stands up under heavy force of packer blade, resists corrosive action of refuse, and abrasive effects of cans, crates, and other materials. To find out how Republic High Strength Steel can pay off in your application, send coupon.

REPUBLIC STEEL WIRE of consistently uniform quality that assures accurate, easy forming with adequate strength and toughness to meet the most difficult design and forming problems. Strong, ductile, tough, Republic Steel Wire is available in many types and in a wide range of gages and physicals for almost any product you can imagine. The variety of products illustrated above are examples of "imagenuity in wire"—engineering imagination plus modern business ingenuity. Write for more information.



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MD's and Engineers Studying Together; The Aim—Better Medical Equipment

PHILADELPHIA—A bold venture in education—the fusion of engineering and medicine—is taking shape at Drexel Institute of Technology here.

Such a blending is crucially necessary, says the person most directly responsible for the experiment: Dr James W. Dow, a medical researcher at Philadelphia's Presbyterian Hospital, who is also an adjunct professor of medical science at Drexel.

Engineering today, he feels, holds vast untapped possibilities for new equipment to improve the quality and extend the scope of medical investigation. But the medical researcher does not know how to communicate his needs in terms that the engineer can understand, and the engineer has no conception of physiological problems. As a result, says the Philadelphian, when the two professions try to cooperate, the equipment that results is often useless—and ill-feeling may develop between the people involved.

To remedy this situation, Drexel Institute of Technology, in collaboration with Presbyterian Hospital, with the help of a $274,000 grant from the National Heart Institute, has established a master's degree program for both engineers and doctors.

Physicians will take concentrated courses in mathematics, electronic and mechanical engineering; the engineers in turn will study biology and physiology. The two groups will then continue with a joint program in advanced engineering subjects. Dr Dow has been named director of the program.

A key part of the program is the joint research on which both doctors and engineers will cooperate. Each project will be carefully chosen so that, within the time available, the group can make a well-defined research contribution. The MD's on the program will lead in designing physiological research—and the engineers, in the conception and creation of instrumentation necessary for that research. This project illustrates the basic philosophy of the program: learning how to work together on biological problems that yield to precise measurement and analysis.

The first class is now enrolled. It consists of two MD's and three engineers. The MD's, who must fulfill 76 credit hours for their degree, began last September. They will be joined this June by the engineers, who will need only 50 credit hours. The three engineers already accepted for admission all graduated in electronics. But mechanical and even chemical engineers will doubtless be admitted in the future. The two groups will study independently this summer; then have classes together next fall.

This summer, the engineers will cover such exclusively biological studies as cell structure, organization of tissues, transfer of materials across membranes, elasticity, and gross and microscopic anatomical structure. They will also take a course in advanced calculus and some atomic physics with emphasis on radioactivity, ionization and materials, etc.

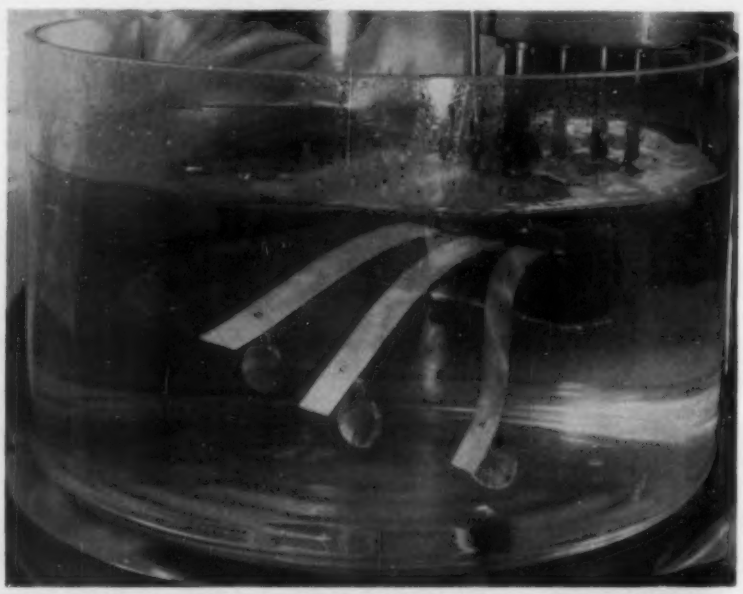
When the groups join next fall, they will cover such biophysical topics as: the body as a thermodynamic system, mechanical engineering of the body, electrical analog of the cardiovascular system, and mechanical ventilation of the lung. Other courses in systems engineering and medical physics will include servomechanisms and feedback, acoustics, and a variety of electronic measurement courses.

WHAT MAY COME OF IT

It would be foolish to try to predict in advance what might emerge from such a program, Dr Dow emphasizes. When two highly advanced disciplines join, much unexpected intellectual excitement usually results. At the very least, the medical profession will be in a far better position to get special equipment it desperately needs. The extensive research of the past few years holds immense possibilities for medicine.

At the end of World War II, Dr

New PVC Able to Take Higher Heat



Hi-temp Geon, a new rigid vinyl developed by B F Goodrich Chemical Co, is said to extend usefulness of conventional PVC by an additional 60 F without sacrificing corrosion resistance, low conductivity, nonflammability and impact strength. Technically called polyvinyl dichloride, it differs from previous PVC's in its higher percentage of chlorine. Photo shows four test strips submerged in 180-F water with Hi-temp Geon (dark strip at left) retaining flexural strength while nylon, linear polyethylene and conventional vinyl sag under the load. New vinyl also rates over polypropylene. Plastic piping made from the material has withstood 150 psi at 200 F—normal household pressure is 60 psi. Now produced on pilot plant scale, it is expected to have numerous industrial applications, starting with hot water piping.

Dow says, about the most sophisticated equipment available to the MD was the electrocardiagraph. After the war a few companies began adapting their existing technology to medical equipment—provided they could identify a market. One such adaptation was the pressure transducer to replace the column-of-water technique for measuring arterial and venous blood pressure. Now, the medical researcher gathers a mass of data, but he has no equipment for reducing them to something meaningful. He still lacks instruments for taking many of the measurements he wants: a device to measure power output of the heart, for example; or instruments to determine heart volumes and outputs accurately.

Much of today's equipment has taken longer to develop than it should have. Perhaps the most successful cooperation between engineers and doctors was development of heart-lung bypass equipment. This took 15 years to develop; should have taken only about two. The original work was done by MD's who learned a little engineering through trial and error. Finally engineers were brought in through the cooperation of IBM. The brilliantly engineered equipment they turned out was ancestor to the first satisfactory heart-lung machines. IBM machines have now been put to extensive and successful use at the Mayo Clinic by Dr John Kisklin and his team.

However, the most important contribution of the engineer to medicine Dr Dow predicts, will be the new approaches he may inspire in collaboration with his medical colleagues. In medicine, any explanation with a hint of purposefulness instead of mechanism, is taboo. In talking about the heart, the MD must carefully stick to a sort of Rube Goldbergian description of a pressure increase that causes an increase in blood flow, which in turn causes some other physical change. The doctor must choose his words very carefully when he suggests to his colleagues that the heart, no matter what, will function to maintain blood flow to all portions of the body. All changes in pressure, rate of blood flow, etc., simply serve this function. Perhaps the engineer, with some of his concepts of feedback and systems engineering, will encourage a more realistic approach to such problems of medical technology.

EXPENSIVE EDUCATION

At present, the cost of the Drexel program is very high. To break even with 20-25 students enrolled would require a tuition of $800 a quarter. If the full charge were made to each individual, that means an MS degree would run $5600 for the medic and $3200 for the engineer. Some scholarship help is now available and Dr Dow hopes that some of the philanthropic foundations will offer additional scholarship aid. Also, large companies may sponsor scholarships or send their own employes. Many companies now have medical-instrument development programs, headed by people training in physiology. The Armed Services have also shown interest in sending some of their researchers.

The Drexel program is not the only attempt to further medicine by introducing engineering. Similar programs are in operation or under consideration in a number of schools. The Univ of Nebraska is starting a small-scale program very similar to Drexel's. John Hopkins has worked out a curriculum for a 4-year program, leading to a doctorate in Bio-Medical Engineering, which is now being reviewed by the National Institute of Health. Under the proposed Hopkins program, only engineers will be admitted. They will have a thorough preparation in the life sciences, hence become specialists in both fields. Graduates will probably head into positions as directors of bio-medical engineering departments. This philosophy is in sharp contrast to the Drexel's cooperative program. ■

FAA Seeks Royalty Rebates on Its R & D Money

WASHINGTON—The government may soon be recapturing a small part of the millions of dollars it pumps into industry each year to develop new pieces of equipment. The Federal Aviation Agency has launched a new approach to getting back into government coffers part of the money it pays out to companies for research and development. The agency is currently working out the details whereby it will require companies obtaining patents from government-financed programs to pay the government royalties amounting to around 6% of the sales price of such equipment sold commercially.

First test of the policy is being negotiated with General Precision Inc of Pleasantville, NY, on computing equipment it developed under a $30-million FAA contract. Money paid in to the government under the FAA plan would go to the Treasury. ■

Drive Is on for National Plastics Institute

NEW YORK—A nine-man committee, drawn from major companies within the $3-billion-a-year US plastics industry, is probing the possibility of creating a national plastics institute.

According to industry representatives, such an institute would conduct basic research into fundamental nature and behavior of plastics, and then conduct applied research on the conversion of plastics into end products. It would establish a comprehensive technical library and information service for its members. In addition, it would increase graduate school opportunities for qualified plastics engineers and chemists.

The committee is now urging the idea on the industry and will ask the individual companies for an affirmative decision before September. ■

Tiros' Timer Warms to its Task

WASHINGTON—Heat from absorbed sunlight is thought to have repaired a break in the timing mechanism that controls the narrow-angle camera on the US "weather eye" satellite, Tiros I. The remote controls worked for only one day after Tiros was launched; they were dead for the next 39 days before they resumed operation.

It is thought that a small joint in the mechanism's wiring opened at low temperature, breaking a contact. Absorbed sunlight may have closed the joint and reestablished the contact. Now there is guessing whether another such cooling may cause another failure.

The timing mechanism permits investigators to program areas of the earth's cloud cover that will be photographed by Tiros' narrow-angle hig resolution camera. While the timer was inoperative, use of the camera was limited to direct commands during periods when the satellite was near the Fort Monmouth, NJ, and Kaena Point, Hawaii stations. ■

Reynolds Aluminum HOLOBAR™

helps lower aircraft landing gear costs

Reynolds Aluminum Holobar is aluminum bar stock *minus the core.* And it's the stock that enables Menasco Manufacturing Company of California, subcontractor for the Chance Vought F8U-1 Crusader, to cut its machining time, simplify its chip problems, and assure closer tolerances in the production of landing gear parts.

The major expense in manufacturing any round or cylindrical part is often the removal of interior metal—and Reynolds Holobar eliminates all the drilling and most of the boring costs. It helps reduce the chip removal, storage and resale problems as well.

Menasco Manufacturing Company found Reynolds Holobar has the right strength-to-weight ratio for adapters, bearings, gland nuts, retaining nuts and lock rings for landing gear components.

In addition, Reynolds Aluminum Holobar assures wall-to-wall mechanical soundness and uniform physical properties. Solid bar stock often has core-to-surface variation. Reynolds Holobar does not. The heat and pressure generated in machining solid bar stock are greatly eliminated, so closer tolerances can be held.

Reynolds Aluminum tubing saves more than machining and production costs. The weight savings of pre-removed metal makes

Watch Reynolds TV shows: "BOURBON STREET BEAT", "ADVENTURES IN PARADISE"; and "ALL STAR GOLF" (resuming in October) —ABC-TV

REYNOLDS

. . . and assures close tolerances

handling and loading operations easier, faster. Easy to machine and thread, Reynolds Holobar is more economical than bar stock in initial per-foot cost.

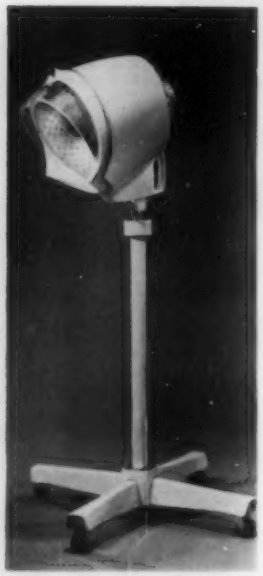
It is available in alloys 2024, 6061 and 7075. Sizes range from 1″ to 8″ O.D., and wall thicknesses from .095″ to 1.25″. Not all alloys are available in all sizes, however. Reynolds Holobar is just one more way in which aluminum—and Reynolds—serves aircraft and other industries. For full details on Reynolds Holobar Seamless Mechanical Tubing, contact your Reynolds Distributor or write direct to *Reynolds Metals Company, P.O. Box 2346-HN, Richmond 18, Virginia.*

Reynolds Aluminum Holobar is used here in the manufacture of landing gear assemblies—adapters, bearings, gland nuts, retaining rings and lock rings.

ALUMINUM

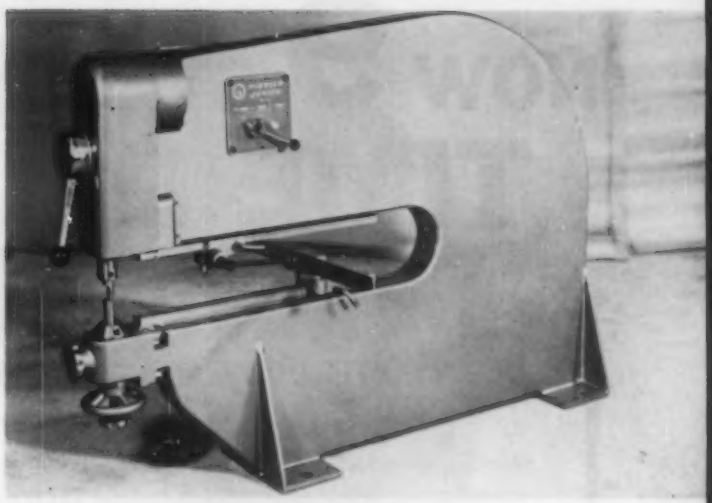
CIRCLE 23 ON READER SERVICE CARD

TRENDS IN APPEARANCE DESIGN



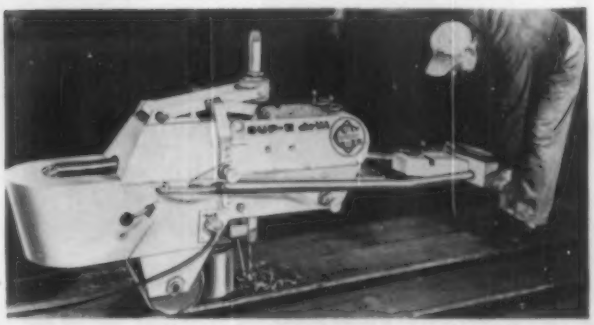
HAIR DRYERS typical of beauty shops (far left) have always required their victims to keep their heads deep within the sheetmetal air-ducting shell that forms greater part of the housing. This meant that the customer's entire head was enveloped in high-temperature air current throughout period of use, and virtually isolated by noise from the dryer's blower. Industrial designer Raymond Spilman, New York, proposed plastic ducting. Transparency eliminates claustrophobic effects, and shape controls air stream so that customer experiences less discomfort from heat and she can hear normal conversation. Made by Halliwell Inc.

CASTERS have long been hidden by many furniture and appliance designers. Believing that this hurt sales, Faultless Caster Co asked Don Dailey & Assoc, Evansville, Ind, industrial designers, to design a caster attractive enough to remain visible. Putting the halves of a caster wheel on either side of the traditional "horn" or axle-bearing yoke (see smaller picture), rather than within it, was the answer proposed. The manufacturer was presented with a prototype having a 3-in. wheel size. The problems of developing a suitable method of staking, determining bearing points, wear resistance and selecting materials were responsibility of the Faultless engineering staff. Butyrate was finally chosen as material for the wheels, and a diecasting for the horn. This allowed using a steel axle with zinc bushing.

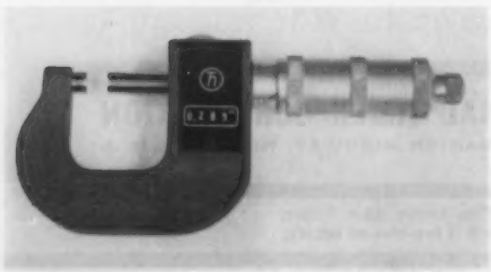


BENCH-TOP NIBBLER for sheet and plate was designed for model shops, engineering departments, R & D labs; has throat depth of 28½ in. Standard control wheels, knobs, levers—and even some structural shapes—are united in this tool with the easy-to-maintain and versatile look of functionalism. Swedish-made and available from Homestrand Tool Corp, Greenwich, Conn.

FILMSTRIP PROJECTOR, 2-speed phonograph and a screen (inside carrying-case lid) large enough for small groups, weigh only 10½ lb. Elevation control holds projector at proper angle for showing without makeshift blocking. Much of the design interest of this unit is in shape of projector housing, created by recess that permits placing records up to 12 in. dia in min space. This dramatically simple shape is marred, however, by fastener heads and parti-colored decoration of base. Made by Dukane Corp, St Charles, Ill.



PORTABLE ELECTRIC DRILL also reams or countersinks holes up to 1½ in. dia (larger with adapter) in very large equipment in permanent installations, or in large, heavy structural shapes. Control of 1-ton electric magnet, 5-hp motor and 4-speed gear shift is centered in yoke-mounted control center. Operator stands either on ground beside work or on it (as in picture) where, apparently, view of work area is largely obscured by stainless steel housing. Also, name and manufacturer's symbol seem oversize. Aluminum castings help limit weight to 730 lb. Made by Guibert Steel Co, Pittsburgh.



DIRECT-READING MICROMETER combines this classic type of measuring device with counter. Usual massive yoke-type housing is emphasized in this case by large, severely simple black rectangle and clear white figures, which provide readings to 1/1000 in. Developed by Thielecke & Co, West Germany.

NOW 9 STANDARD TYPE TIME DELAY TIMERS

IN AN EXTENDED RANGE OF TIME CYCLES

1/60th of a second to 24 hours

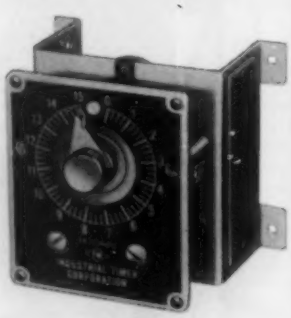
For bigger savings in OEM design and installation now, choose a standard time delay timer from Industrial Timer's expanding line to satisfy almost *every* mounting requirement... back, side, flush, through-the-panel, totally enclosed or explosion proof. Industrial Timer's bigger-than-ever selection gives you greater design latitude in both function and appearance... eliminates the need for costly custom-made controls in your specifications.

All 9 types have these special features:

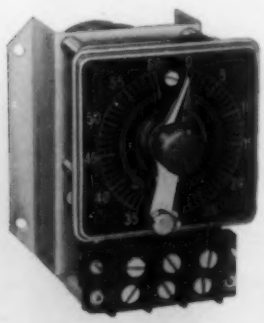
1. Actuated by momentary *or* sustained pulse
2. Automatic reset
3. Heavy duty load switches rated at 10 and 15 amps
4. Easy, positive adjustment of time cycles

By specifying Industrial Timer you are assured of accurate and dependable controls for applications requiring a specific time delay between circuit operations. Full details in Bulletins 300, 800 and 900.

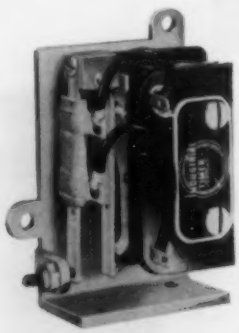
Series 90
Back-mounted, for applications where time cycle is infrequently changed or permanently fixed (½ sec. to 5 min.)



Series SF
Back-mounted (1/10 sec. to 5 min.)



Series TDAB
Flush-, back-mounted or totally enclosed (1/60 sec. to 3 hrs.)



Series TH
Back or bottom-mounted. Thermal time delay switch. (15 sec. to 2 min.)

Series TDXP
Bottom or back-mounted. Explosion proof. External adjustments (1/60 sec. to 3 hrs.)

Timers that Control the Pulse Beat of Industry

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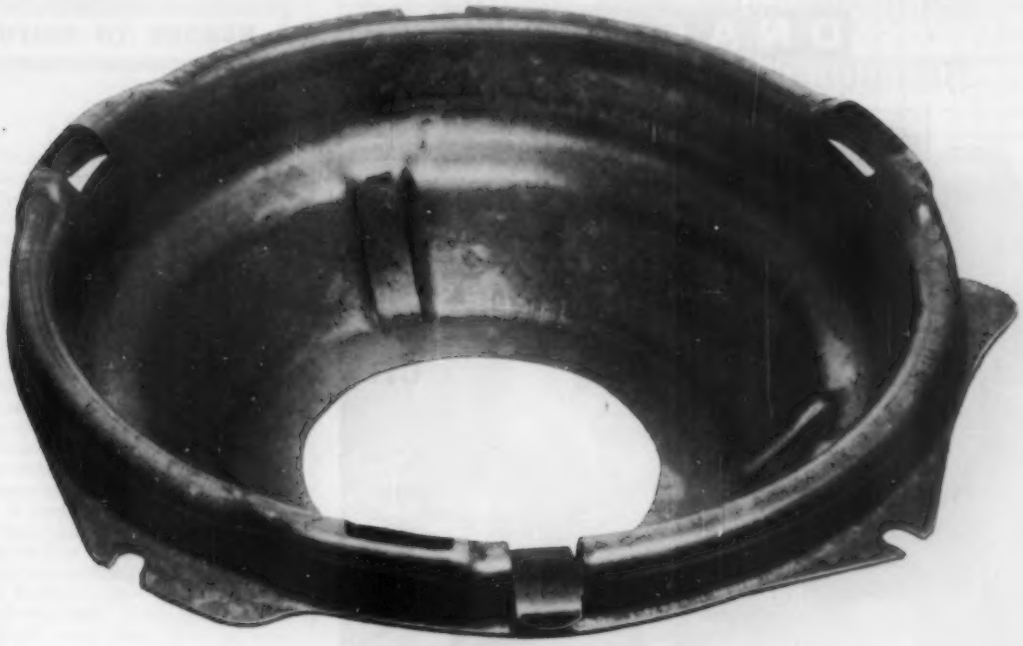
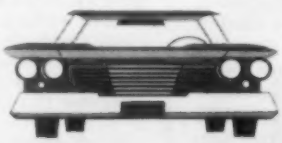
Industrial Timer's complete line also includes: Interval Timers, Running Time Meters, Cam Timers, Explosion Proof Timers, and Programmers. Our 40-page catalog describing these is available on request.

Better products through better methods and steels



(or how zinc-coated steel cut 5 steps from auto lamp housing fabrication). When automotive head and tail lamp housings were drawn from cold rolled sheet steel and then zinc-plated or painted, as many as five or six handling and cleaning steps were required to make them corrosion-resistant. Now, fabricated from Weirkote continuous-process zinc-coated steel, the housings go directly from the press to the assembly line. Further processing is unnecessary because Weirkote can be worked to the limits of the steel itself without chipping or flaking its corrosion-resistant zinc surface. It's this superiority that caused the automobile industry to increase its consumption of zinc-coated steel more than 700% in five years; to use it in such varied applications as mufflers, window channels and the understructures of unitized bodies; to take



advantage of developments such as differentially zinc-coated steel that can be welded at top production-line speeds. A major supplier is Weirton Steel Company—producer of Weirkote continuous-process zinc-coated steel and many other fine steels that improve products, methods and profits throughout industry.

WEIRTON STEEL
Weirton, West Virginia

WEIRTON STEEL COMPANY

Weirton Steel is a division of **NATIONAL STEEL CORPORATION**

Weirkote will also be available in 1961 from National's Midwest Steel Division, Portage, Indiana.

CIRCLE 27 ON READER SERVICE CARD

DRAFTING TRENDS

Inspecting the "locked-in" black image of POST *208TC, Vapo Tracing Cloth, are Mort Fishman of Sabatino & Fishman, Architects, and Mike Ceglia of Bernard Sacks & Associates. Mike Conlin, sales representative of local* POST *dealer, Philadelphia Blueprint Company, looks on.*

Philadelphia engineers save hours per tracing

Remarkable reductions in drafting time, up to 40 hours per tracing, have been achieved by Bernard Sacks & Associates, Philadelphia engineering consultants.

Specializing in heating, plumbing, ventilating, electrical and structural work, this firm receives basic floor plans from architect clients, then makes up separate detailed plans for each construction trade involved.

Bernard Sacks & Associates employs a system using POST 208TC Vapo Tracing Cloth, a positive-to-positive diazo process material. It reproduces with a dense, "locked-in" black image. The original drawing is reproduced on this intermediate product, one for each subcontractor. In most instances, film positives of standard details can be overlaid on the original drawing before the intermediate is made, thus saving considerable drafting time.

Custom details or revisions are drawn directly on the 208TC intermediate, thanks to its excellent ink and pencil line receptivity. The finished plan is a combination of basic floor plan, transparent base overlays and additional drafting. It can be duplicated in quantity by any reproduction process.

POST Tracing Cloth intermediates, as in the above instance, are used in a wide variety of applications by many industries to help reduce costly board time. *For more information on* POST *208TC (black image) or 209TC (sepia image), and how they can help your company produce drawings and prints more economically, write to Frederick Post Company, 3642 Avondale Avenue, Chicago 18, Illinois.*

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ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE

READER TO EDITOR

What Is An Engineer?

To the Editor:

I have read nearly every article you have had on engineering in the section, "Points of View." I enjoyed the discussion of engineers & draftsmen, Apr 11, p 26. It is my opinion that no man who does not have thorough training in basic principles of engineering and drafting, which is the language of engineering, is worthy of the title of Professional Engineer. If the "engineer" is sure that he wants only analytical, test, or development work, he is not worthy of the name, but is a mere technician, no matter how many degrees he may hold. An engineer who is an engineer should speak, write, and understand the language of engineering. Furthermore, he is one willing to submit himself to the discipline necessary to learn these things. Otherwise, it would be well for him to become a research scientist or a modernistic painter.

—W H SAYLER
Specialty Sales Co
Salt Lake City 1, Utah

GEM's that Fly High

To the Editor:

We were pleased to see your article on ground-effect machines in the Apr 25 issue of PRODUCT ENGINEERING as evidence of growing recognition of these vehicles.

As a matter of history, our company, National Research Associates, was the first US firm to work on ground-effect machines and the first government contract in this field was with us.

Based on our own experience, we feel you have somewhat underestimated the state of the art in these vehicles. For instance, through the use of specialized design features (patents pending), we have demonstrated stability at heights greater than twice the 5% diameter values mentioned in your article and we have developed an effective control system which does not require additional power.

We feel that ground-effect machines are now practical for use in specialized applications. As a matter of interest, we are now working on the GEM III under contract with the Marine Corps. This is a gas turbine-powered vehicle considerably larger than the GEM I, and will be completed this fall.

—M W BEARDSLEY
National Research Associates Inc

What Caused Those Pockmarks?

To the Editor:

The note "Get yourself a 'moon drop'" in the April 11 issue p 32 prompted us to do a few elementary calculations. To determine the direction of free fall of a particle at rest on the earth-moon axis, we must determine the point at which the two gravitational forces are equal.

continued on page 29

READER TO EDITOR.....continued

It turns out that the distance of this point from the center of the moon (in miles) is

$$\frac{244{,}000}{1 + \sqrt{Me/Mm}}$$

Since the ratio Me/Mm is about 80, it would be impossible for a chunk of the moon to be abducted by the earth (unless an additional force, e.g., meteor impacts and explosions, should propel moon fragments into space). Perhaps this is just as well. Imagine the chagrin of a future moon explorer returning to his rocket ship only to find it in free fall back to earth.

What then has caused the many more pockmarks on the face than on the far side of the moon? We have formulated our own theory to explain this difference. Not every meteor in the general vicinity of the earth is captured by its atmosphere or gravitational field; there are many near misses. These meteors limp away from the earth at reduced velocities. The moon is more likely to capture these slow meteors coming from the general direction of the earth than it is to capture those coming from outer space at full speed—and on so doing, it is hit more frequently on the side which always faces the earth. Moon travelers might care to consider this in selecting camp sites.

—H. B. Bomberger and
H. A. Clampett
Midland, Penna

COMING EVENTS

JUNE

5-9 . . . . American Society of Mechanical Engineers, Semiannual Meeting and Aviation Conference, Statler-Hilton Hotel, Dallas

5-10 . . . . Society of Automotive Engineers, Summer Meeting, Edgewater Beach Hotel, Chicago

13-15 . . . . Metal Powder Industries Federation and American Institute of Mining, Metallurgical & Petroleum Engineers, jointly sponsoring International Powder Metallurgy Conference, Hotel Biltmore, NYC

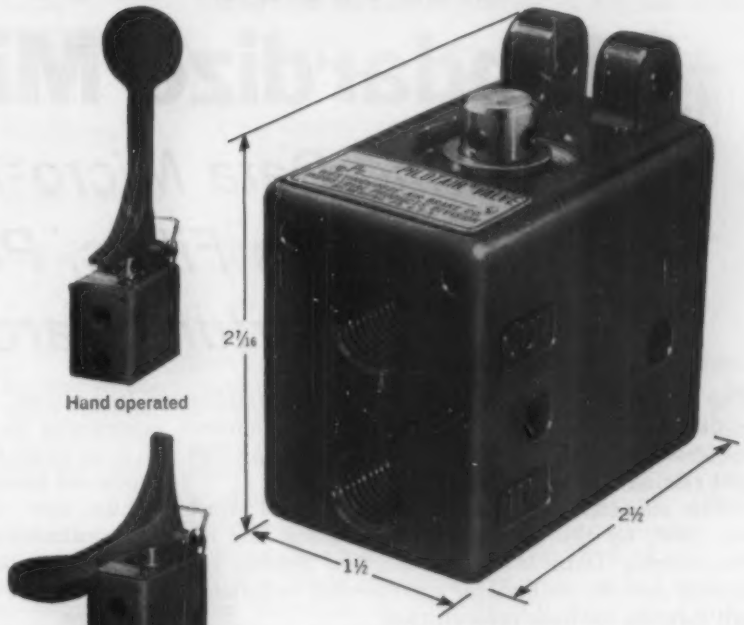
19-21 . . . . Alloy Casting Institute, Annual Meeting, The Homestead, Hot Springs, Va

20-24 . . . . American Society for Engineering Education, 68th Annual Convention, Purdue Univ, Lafayette, Ind

27-29 . . . . Institute of Radio Engineers, 4th National Convention on Military Electronics, Sheraton Park Hotel, Washington, DC

27-July 1 . . . . American Society for Testing Materials, 63rd Annual Meeting, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

another new Westinghouse AIR CIRCUITRY Component



Hand operated

Foot operated

Air pilot operated

Cam roller operated

Cam dog operated

Type "A" PILOTAIR® Valve

Don't let the size of these little poppet-type directional valves fool you.

They can open, close or vent an air circuit as quickly, efficiently and dependably as models twice their size.

For despite their compactness (actual dimensions are 1½" x 2½" x 2 1/16"—and they weigh less than 16 oz.), the short travel action of poppet valve construction produces fast response for full valve capacity.

Type "A" Pilotair Valves are enclosed in a solid, die cast aluminum block for ease of installation and ruggedness. They are designed for lever, mechanical or air operation. Maximum inlet pressure is 250 psi. Maximum operating temperature is minus 40°F to plus 200°F. Pipe taps are ¼" N.P.T.

AIR CIRCUITRY—FOR TROUBLE-FREE AUTOMATION

Air Circuitry is the application of pneumatic control systems to industrial production operations.

Air circuits are safe, economical and precise and are used to solve the most rigorous and complex control problems in industry.

Our engineers, backed by 90 years of experience, can help you boost production and cut costs in your plant.

AIR CIRCUITRY means trouble-free automation

For more information, ask for Catalog A4-74:00

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.

WESTINGHOUSE AIR BRAKE COMPANY
INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

Armed Forces Standardize Microfilm

Engineering Data Micro-reproduction System Covers Films, Punch Cards, Aperture Cards

The Armed Forces, operating active files containing more than 50 million drawings, have set military requirements for microfilming engineering drawings and related data.

The standards and specifications released April 15, 1960, by the Department of Defense for its Engineering Data Micro-reproduction System establish uniform methods for microfilming and standard formats for data presentation.

These uniform methods and standard formats, the Defense Department said, offer great space, time, and money savings.

New possibilities for inter-service exchange of engineering data are opened through the use of microfilmed drawings and related data, the Department of Defense announced.

What does this mean to industry?

Military agencies using the specifications of the Engineering Data Micro-reproduction System will ask contractors to submit engineering data in 35mm roll microfilm and punch cards. From the microfilm and punch cards, such military agencies make aperture cards to distribute engineering data for the procurement, maintenance, and supply of the nation's weapons systems.

In addition, other military agencies may require contractors to submit completed aperture cards. In these cases, the master microfilm and distribution copies are furnished in mounted aperture cards.

Even now, a number of prime contractors and sub-contractors are using a portion of the newly-adopted specifications and standards. For them, the new requirements will be integrated into existing programs.

Many contractors, anticipating the standards and specifications, have held microfilm programs in abeyance. Their engineering departments now have a ready-made set of instructions for upcoming programs.

The new standards and specifications are expected to have a cumulative effect. As more companies have microfilm equipment, industry will intensify its use of microfilm for distributing data. Even before specifications were announced, prime and sub-contractors were exchanging engineering data in microfilm format.

Industry helped set standards

Compatibility with industry is the keystone in the new standards and specifications of the Department of Defense. Industry originates much of the engineering data used by the DOD. Industry, in helping to set requirements, has created instructions that can be used for its own operations.

Standards cover broad areas

The standards and specifications documents already released are:

MIL-M-9868, Microfilming of Engineering Documents, 35mm Requirements for;

MIL-P-9879, Photographing of Construction/ Architectural Drawings, Maps and Related Documents, 105mm, requirements for;

MIL-C-9877, Cards, Aperture;

MIL-C-9878 Cards, Tabulating and Aperture for Engineering Data Micro-reproduction System;

MIL-STD 804, Formats and Coding of Tabulating and Aperture Cards for Engineering Data Micro-reproduction System;

MS-21319, Gage, Aperture Cards No. 201-1.

Interim Federal Specifications cover silver halide, diazo-type, and heat developing microfilm.

The complete Department of Defense standards and specifications cover:

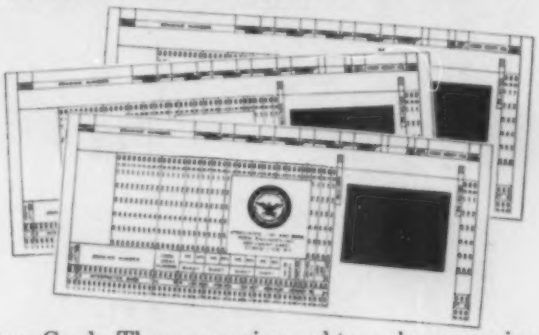
- The raw film stock used in microfilm;
- The methods and techniques of microfilming engineering data for the Armed Forces;
- The formats of the tabulating cards used to generate aperture cards;
- The formats of the aperture cards used as carriers for the microfilm data;
- The methods and techniques of mounting microfilm into aperture cards;
- The wide range of equipment to be used in the micro-reproduction system. This equipment includes microfilm cameras, testing equipment to inspect filmed engineering data, film mounters, film printers, and print-out units.

3M makes microfilm so easy to use

You can depend on 3M's continuing research, precision manufacturing, and standards-compatible products to make microfilm so easy to use.

FILMSORT Aperture Cards and Copy Cards, long used by Government and industry, are designed to meet the specifications and standards for the Engineering Data Micro-reproduction System. And now, to speed your use of FILMSORT Aperture Cards, 3M supplies both the printed card and the aperture. You save in shipping costs. You get your cards faster.

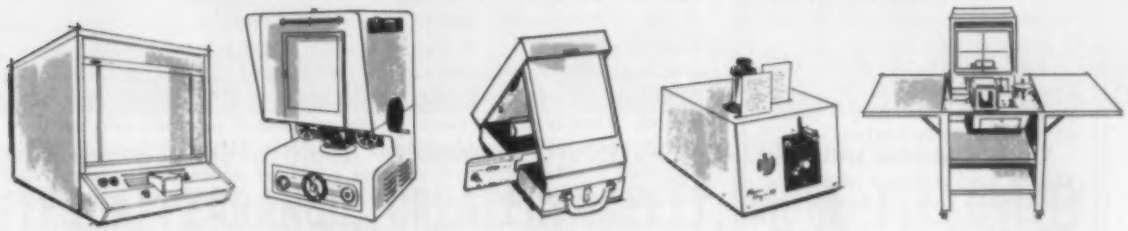
FILMSORT Microfilm Copiers, Mounters, and Readers are designed exclusively for Filmsort Aperture Cards. They are engineered to make your micro-reproduction system profitable.



THERMO-FAX "Filmac 200" Reader-Printers make microfilm practical for industry and Government. The advantages of a reader and a printer are combined in one compact, low cost unit. Huge viewing screen . . . simple push-button operation . . . you can obtain copy after copy in 18″ x 24″ size, or half size prints, of engineering drawings and records from microfilm in FILMSORT Aperture Cards. The "Filmac 100" Reader-Printer delivers 8½″ x 11″ copies in seconds.

For more information about the new Defense Department microfilm specifications and how they affect your business, mail the coupon right away.

Modern Microfilm Products from 3M



THERMO-FAX "Filmac 200" Reader-Printer

THERMO-FAX "Filmac 100" Reader-Printer

FILMSORT "Inspector 50" Reader

FILMSORT "Uniprinter" Copier

FILMSORT Semiautomatic Optical Mounter

3M COMPANY

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THE TERMS "FILMSORT," "INSPECTOR," "UNIPRINTER," AND "THERMO-FAX" ARE REGISTERED TRADEMARKS OF

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Minnesota Mining and Manufacturing Company,
Dept. FBN-5300, St. Paul 6, Minnesota

Please send detailed information on the new Department of Defense standards and specifications and about 3M Microfilm Products.

Name_____

Title_____

Company_____

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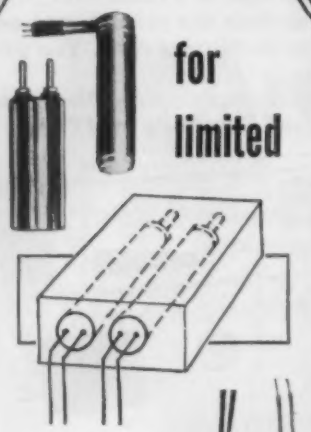
City_____ Zone___ State_____



for limited space, specify...

VULCAN CARTRIDGE HEATERS

Vulcan Cartridge Heaters are designed especially to provide concentrated heat in small areas by insertion into machine parts, dies, platens, molds, presses, die blocks of embossing machines, packaging machines, etc. There is practically no heat loss because the cartridge is completely surrounded by the metal or material to be heated.

Vulcan Cartridges are available in a wide choice of standard sizes — from 1″ to 25″ (or longer); diameter — 1/4″ to 1 19/64″ (or greater); sheath — brass, steel, nickel or high temperature alloys; full range of wattage and voltage ratings. The proven "Thunderbolt" Heater is available for extreme conditions of watt density and temperature.

Write for catalog and prices.

VULCAN

Versatility in Electric Heating

VULCAN ELECTRIC COMPANY, Danvers, Mass.

WHY DON'T THEY R&D..?

. . . an improved mechanical tree-planter to replace inefficient machines now used to plant forests of soft and hardwoods for the timber and pulp industries. Present tree-planting machines are only a simple form of plow: a wheeled or crawler-type tractor pulls the planter across the field while an operator rides on the machine dropping seedlings into the continuous furrow at approximately 6-ft intervals. At the rear of the planter, a pair of inclined wheels fills in the furrow around the seedling. The machines are inefficient because, instead of a trench, each tree needs only a hole 18 in. deep and about 6 in. dia. They are also wasteful of manpower and machines, requiring two operators and two pieces of machinery (tractor and planter) where one should suffice. In a typical planting season, one company tied up 43 tractors and planters, and 91 crews of men, to plant 22,000,000 seedlings.

The two-row "Goodmonson" tree planter is somewhat more sophisticated than other present machines but retains many disadvantages.

The design of today's planters (above) is essentially unchanged from those built 10 years ago. And though simple and inexpensive, the machine is out of date when measured against other improvements in agricultural technology. In a recent article in Pulpwood Annual, a paper company representative suggests that with improvements in the seedling and fertilization, "improvements should also be applied to the actual technique of getting the tree into the ground. Here is an area where we can get some of our costs into line."

In a study of the problem made at Battelle Memorial Institute, engineers suggested a self-powered vehicle that could be driven by one man. Rather than dig a trench, the planter would move at a steady rate, boring holes just large enough for the seedlings. Either an auger drill or a trenching tool with mechanism similar to a chain saw could be used to make the hole. After the seedling was dropped into the hole by the operator, the trenching unit would replace the pulverized soil and tamp it down. The Battelle engineers estimate that a 10-hp engine should be sufficient to drive this vehicle and to power the planting mechanism.

The Battelle study concludes: "Prior experience with mechanisms of similar complexity indicates that a research and development program to produce a field-tested machine would cost about $25,000. This is but a fraction of research and development costs of most new products in the agricultural and forestry-machinery field, and such a self-contained tree planter might be an excellent diversification opportunity for some manufacturer as well as a needed tool for the timber and pulp industries."

Have you a problem, based on known scientific principles, which seems to have an answer somewhere within the limits of present technology? To inspire inventors along worthwhile paths, PRODUCT ENGINEERING invites you to trade such problems with fellow readers who have a fresh viewpoint or more time to experiment. We pay $10 for each one accepted.

CIRCLE 33 ON READER SERVICE CARD→

GENERAL ELECTRIC

Developed Exclusively for Tri-Clad* '55' Motors

NEW THERMO-TECTOR SYSTEM POSITIVELY ELIMINATES OVERLOAD BURNOUT

Allows Maximum Motor Output - - Safely!

Now—Tri-Clad '55' motors have simple, direct-acting thermal protectors that *positively* end winding failures from overloads!

New Thermo-Tector heat-sensing switches buried in stator windings react *instantly* to prevent heat damage. Unique Thermo-Tector "anticipation" feature varies motor shutoff point according to rate of winding heat rise. This ends need for operating safety margin.

Thermo-Tector system uses no costly amplifying relays or special circuitry, works with any General Electric motor controller.

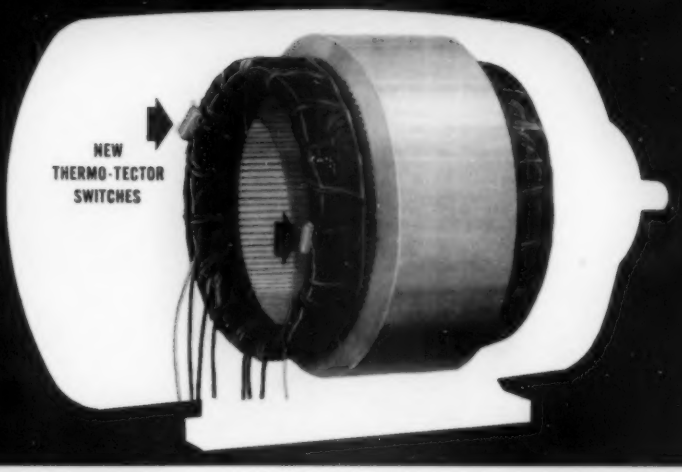
*Registered trade mark of General Electric Co.

TURN PAGE FOR FURTHER INFORMATION

NOW!

GET MAXIMUM MOTOR OUTPUT WITH NO DANGER OF OVERLOAD BURNOUT!

New THERMO-TECTOR System
Operates IN THE STATOR . . .
Protects Under All Conditions!

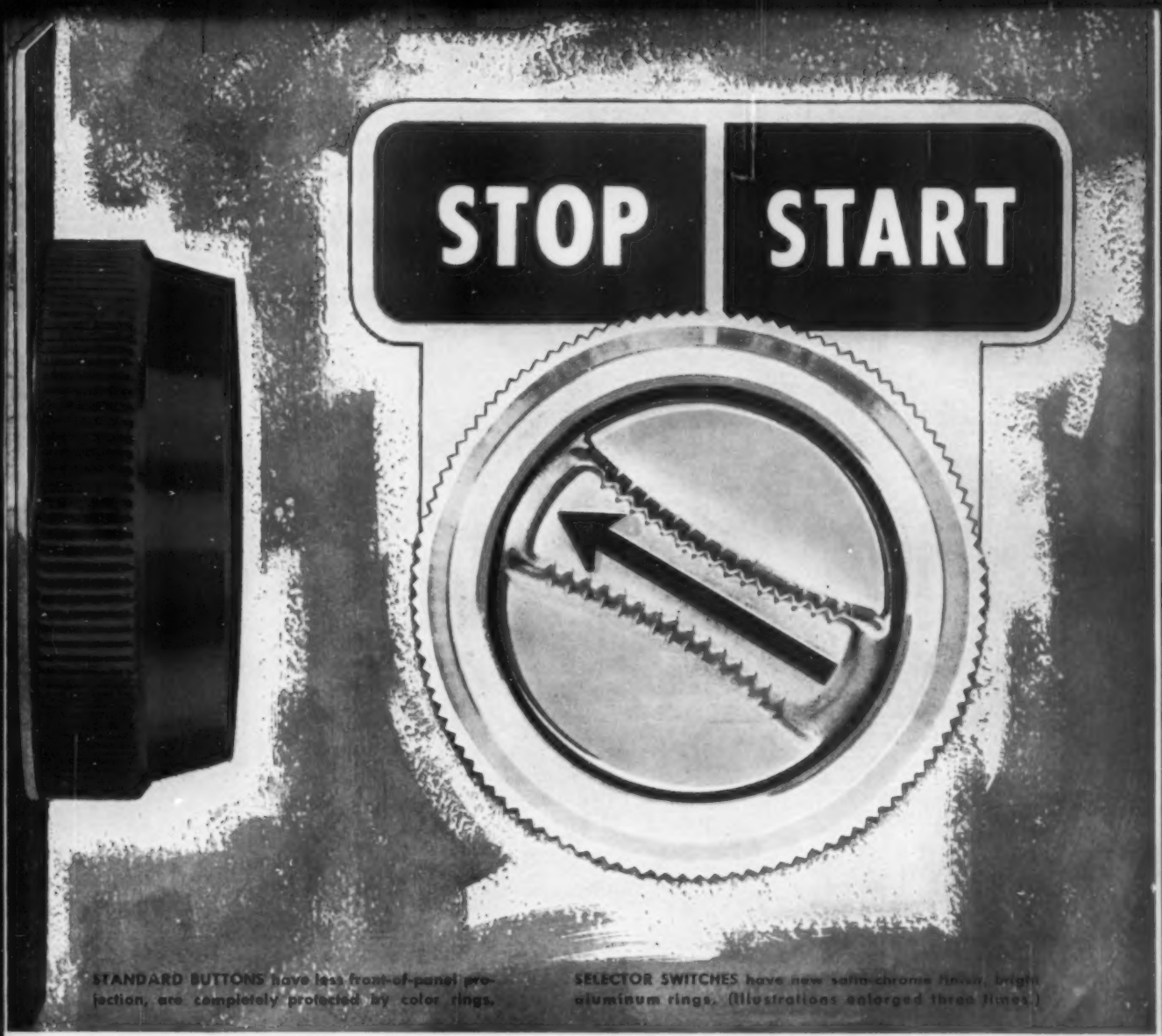


You get *full output* from Tri-Clad '55' motors with Thermo-Tector protection. No operating "safety margin" is necessary since Thermo-Tector switches react instantly to prevent damage from *any* type of winding overload. New General Electric Thermo-Tector switches—buried deeply in the coils of the Tri-Clad '55' motor—are so durable they handle size 4 contactor coil current with *no costly amplifying relays.* Any conventional G-E motor controller works with the Thermo-Tector system.

Thermo-Tector protection is available on *all* Tri-Clad '55' motors in frames 254U-445U. For more information, contact your G-E Apparatus Sales Office or write for Bulletin GEA-7092, Section 866-2, Schenectady 5, N. Y.

SMALL AC MOTOR & GENERATOR DEPARTMENT

GENERAL ELECTRIC



STANDARD BUTTONS have less front-of-panel projection, are completely protected by color rings.

SELECTOR SWITCHES have new satin-chrome finish, bright aluminum rings. (Illustrations enlarged three times.)

Three "measurable advantages" of General Electric CR2940 Oil-tight Pushbuttons:

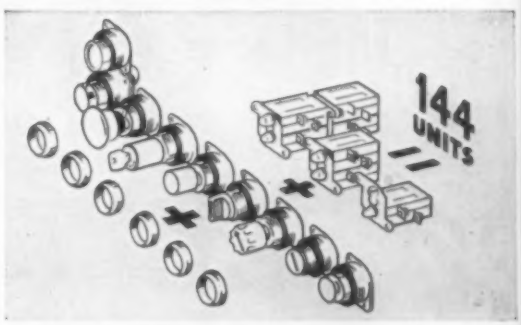
BETTER APPEARANCE, GREATER SAFETY, MORE FLEXIBILITY

When your machines, consoles or panels include CR2940 General Electric oil-tight pushbuttons, you've built in an extra sales advantage that will improve customer acceptance of your products.

The outstanding appearance of G-E units is the result of several exclusive features: pushbutton color coding is permanently anodized on color rings to prevent loss of identification due to dirt and grime, and to provide positive all-angle color identification; new satin-chrome finish on selector switches and bright aluminum rings resist corrosion and wear, blend well with machines or panels.

The rugged, all-metal standard pushbutton operator hugs the panel to avoid accidental damage. Protected buttons also guard against unintentional operation. Write for bulletin GEA-5779, General Electric Company, Schenectady, New York. 731-20

You get
MEASURABLE ADVANTAGES
WITH GENERAL ELECTRIC CONTROL



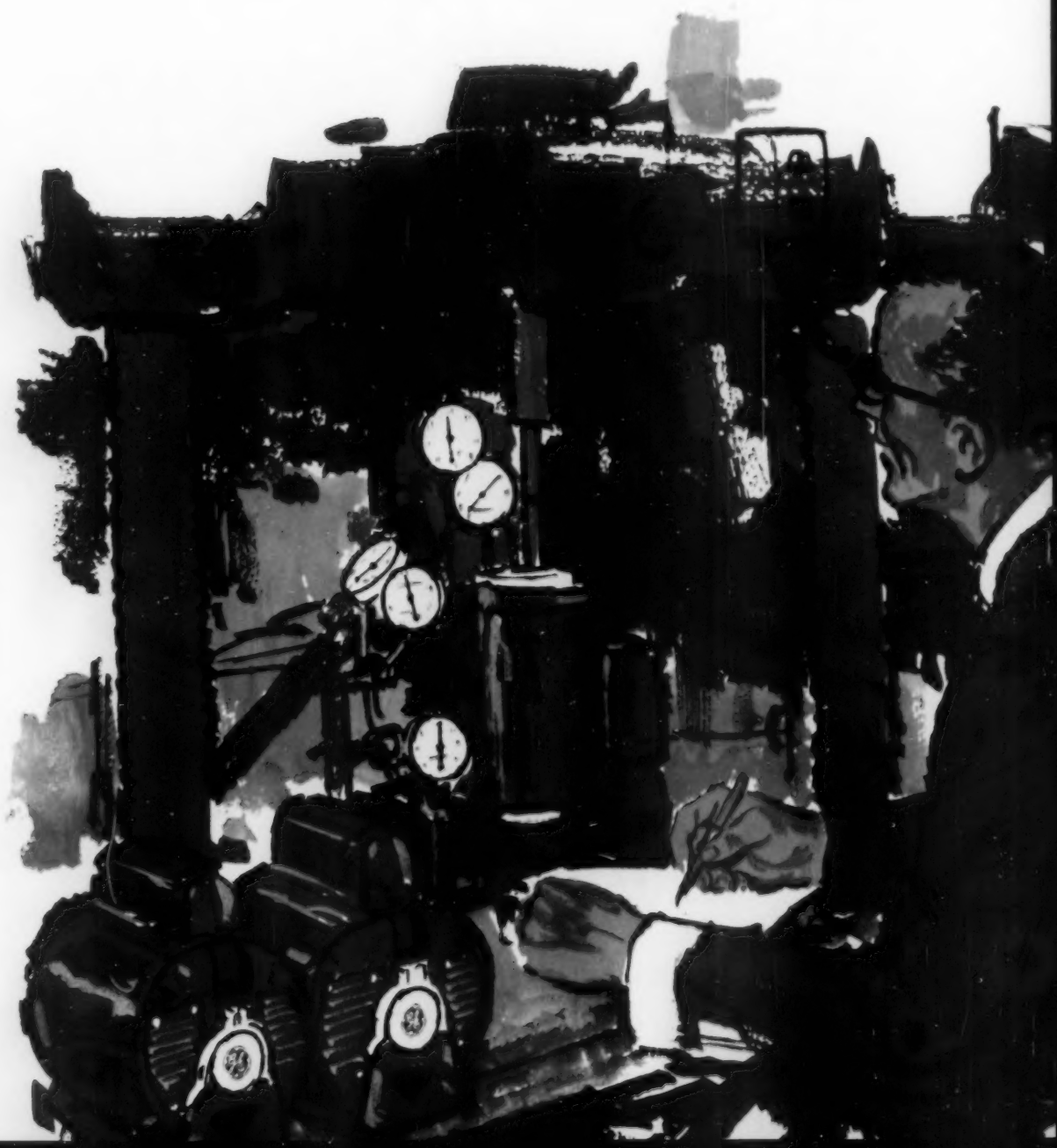
BUILDING BLOCK CONSTRUCTION cuts your stock needs. Just 6 color rings, 8 operators, 3 contact blocks, provide 144 different units. Units can be front- or back-mounted. Variety of separable nameplates adds further versatility.

GENERAL ELECTRIC

You get MORE THAN A MOTOR with General Electric's

Years-Ahead

Form G leadership among fhp motors isn't accidental. We work hard at it, constantly improving, constantly innovating. We've found it's the best way to help our customers keep ahead of the changing demands in their industries. It's good business on our part. It's good business on your part too . . . to make sure you get the advantages a years-ahead motor can offer your product.



Form G...for example...

Design Leadership

FOR A REVIEW of several years-ahead design features of the Form G fhp motor, and some good reasons why it offers you MORE THAN A MOTOR, see the next page.

GENERAL ELECTRIC

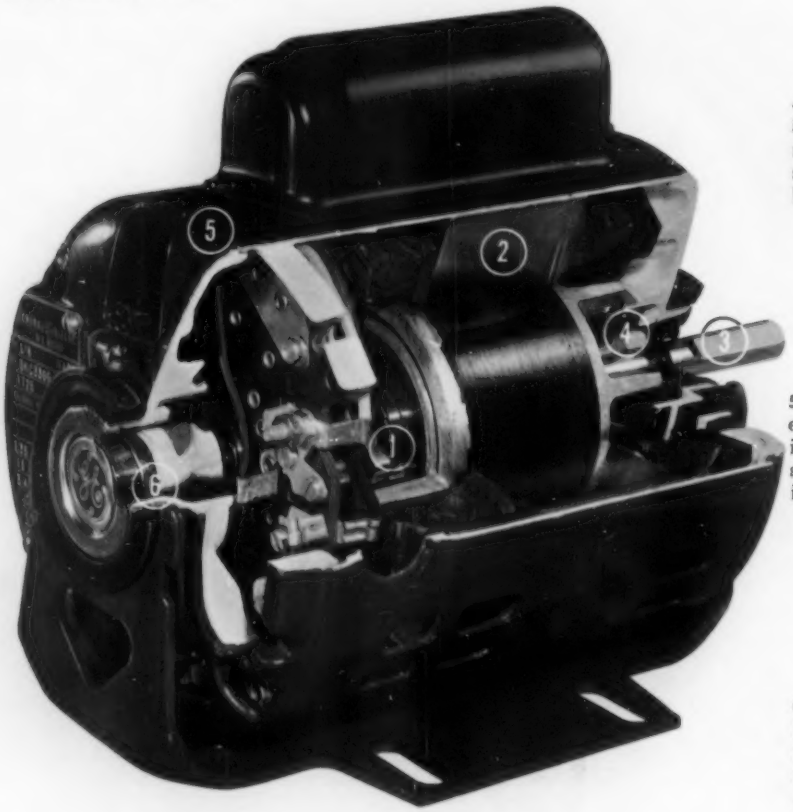
These years-ahead Form G motor features mean long life, reliable performance

1. QUIET SWITCH—specially-designed composition washer in Form G motors cushions start-stop click; maintains positive snap-action; has been tested to last 3,500,000 operations.

2. LONG-LIFE STATOR—heavy-duty stator bonding dip and Mylar* insulation protect against damage caused by heat, stress, moisture. Stator clamps provide additional rigidity.

3. RUST-RESISTANT SHAFT—special gunmetal-like treatment of motor shaft resists rust and corrosion, simplifies product service. Fans, pulleys, and couplings are easy to remove.

*Reg. Trademark of Du Pont Co.



4. LONG-LIFE LUBRICATION—Over 50% more oil than in old-design motors and an efficient oil retention system contribute to motor's doubled lubrication life; cut maintenance.

5. ACCURATE ALIGNMENT—disk-type end shield, heavily ribbed for rigidity, places rabbet and bearing in same plane, provides accurate bearing alignment, long motor life.

6. THRUST PROTECTION—interlocking washer assembly withstands normal thrust from any direction, regardless of motor angle; also acts as an oil seal for long motor life.

Only General Electric Form Gs give you MORE THAN A MOTOR

1. YEARS-AHEAD DESIGN LEADERSHIP—consistent leadership by G.E. keeps Form G customers "out front".

2. EASE OF ASSEMBLY—Form G motors provide assembly-line savings in time and money.

3. EXPERT APPLICATION AID—G-E engineers are always available to help solve unusual motor applications.

4. ON-TIME DELIVERY—multi-plant facilities assure you reliable, prompt delivery of the exact motors you need.

5. VERSATILITY PERSONIFIED—a Form G motor can meet almost any design requirement.

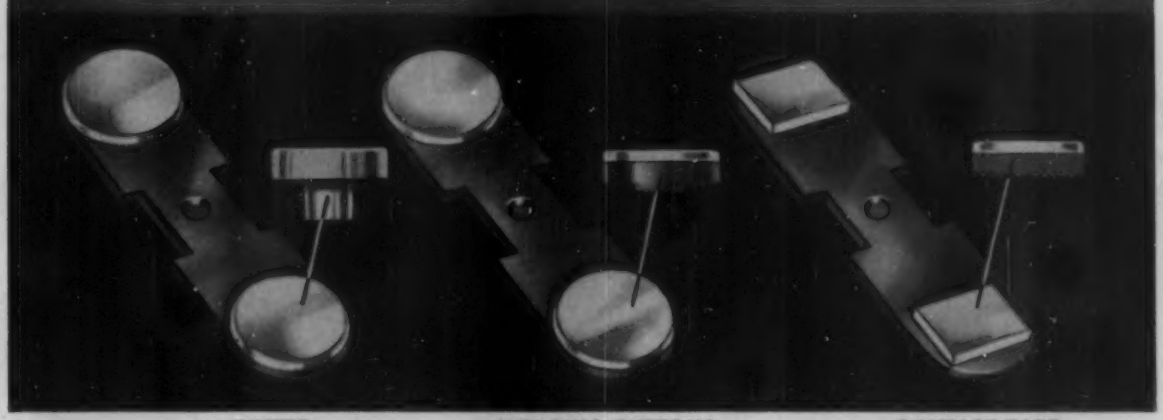
6. FAST, LOCAL SERVICE—a nationwide network of G-E Electric Motor Service Stations means service is always close at hand.

7. QUALITY CONTROL—*every* Form G motor is thoroughly tested at all stages of production to assure you long, dependable performance.

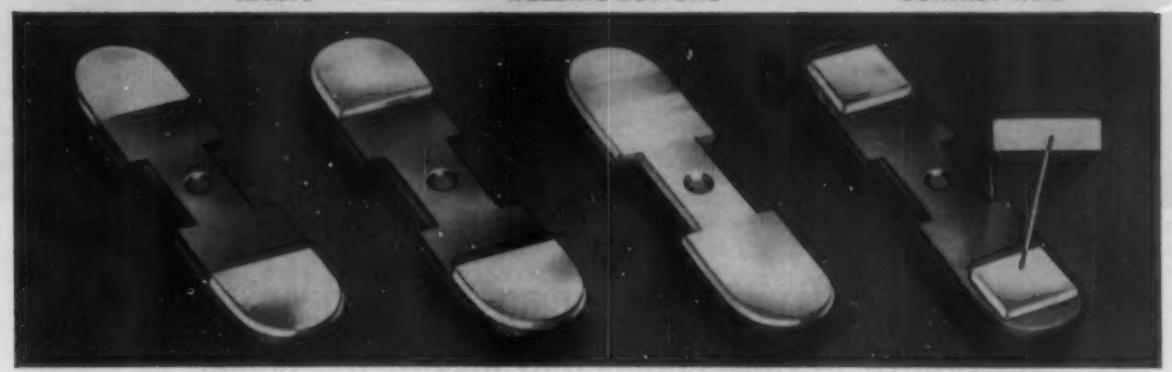
Make sure you get MORE THAN A MOTOR when you select fhp drives for your product . . . choose General Electric Form G motors, available in NEMA 48 and 56 frames. For more information contact your nearby General Electric Apparatus Sales Office or write Section 702-108, General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

? Which Assembly is least expensive ?



RIVETS WELDING BUTTONS CONTACT TAPE



STRIPE TOPLAY OVERLAY BRAZED ASSEMBLIES

Have you re-evaluated your designs lately?
Let General Plate provide the right answer . . .

There are many ways to fabricate the same contact assembly . . . but almost in every case there is always *one best, least expensive way.*

The General Plate products group of Metals & Controls Division produces a complete line of contact assemblies and contact materials. Backed by 43 years of metal cladding experience, we have the facilities and know-how to provide the performance required at the lowest cost.

For Example: recently a manufacturer of automotive components, with the help of Metals & Controls Division Engineers, changed his contact design and increased production by 900% at the same time reduced costs proportionately.

It will pay you to investigate General Plate contacts and materials. We offer . . . complete technical information, engineering design assistance, samples, on-time deliveries. Our competent Field Engineers will gladly call at your request and review your current and future designs without obligation. Write today:

TEXAS INSTRUMENTS
INCORPORATED
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1005 FOREST STREET • ATTLEBORO, MASS.

General Plate Products: Clad Metals • Electrical Contacts • Truflex® —Thermostat Metal • Gold, Silver, Platinum and other Precious Metal Products

Anaconda Vibration Eliminator, 1½" I.D. x 17", installed in liquid fill line of a 9000-gallon liquid oxygen tank installed in a boxcar by Lox Equipment Co.

When –297°F LOX hits the piping, standard Anaconda tin bronze flexible connectors absorb the shock

Flexible metal hose connections used to absorb thermal contraction and shock in piping carrying liquefied gases vary widely in size, material and design. Anaconda makes assemblies in stainless steel up to 14 inches I.D. for LOX lines in missile ground handling equipment—and other special connectors and hoses in a variety of metals down to ⅛ inch I.D.

But there are many places where standard Anaconda flexible metal hose assemblies of tin bronze can do a job dependably and with economy. Lox Equipment Co., Oakland, Cal., makes unfired pressure vessels to hold liquefied gases. To protect valves and piping from stresses set up when liquid oxygen at –297°F or liquid nitrogen at –320°F begins to flow, the company has found standard Anaconda Vibration Eliminators highly satisfactory. These flexible connectors designed for damping vibration in rigid piping of refrigeration systems have the physical properties needed—the high strength, toughness, and fatigue resistance inherent in tin bronze. In fact, these properties are greater at very low temperatures—tensile and yield strength of copper and copper alloys are materially higher at —300°F than at room temperature. Working pressure of 60 psi is no problem, as standard VE's are designed for applications up to 300 psi—in some sizes up to 500 psi.

FREE TECHNICAL SERVICE. Anaconda Metal Hose specialists are constantly working with design engineers on flexible connectors and hose to meet new problems. They may recommend a standard unit or help in the design of a special unit. For information on standard units or engineering assistance, write: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

CIRCLE 40 ON READER SERVICE CARD

ANACONDA®
METAL HOSE

PRODUCT ENGINEERING HORIZONS

May 30, 1960

IS "MAINTAINABILITY" NEXT?

Reliability engineering, which had its origins in common-sense design, began to assume prominence and form when missile development was accelerated. In less than a decade, it has spread all through military "hardware" design, and is now finding proponents in mechanical products for non-military uses. Our special report (May 16) indicated the dimensions of this technique, attempted to separate the solid meat from the fat.

Is "maintainability" the next order of business? The word is a clumsy one, but it means design for ease of maintenance. Again this is a simple and old-fashioned idea, but one being forgotten in a surprising number of instances. It is separate and distinct from reliability—sometimes almost its opposite.

We've gone all out for producibility–for the design that can be made cheaply and at high production rates. We've developed welding, soldering, staking, potting, die-cast assembly, and other processes to replace bolting and screws, so that many subassemblies now are un-maintainable. We even have statistics to prove that it's cheaper to replace than to maintain.

But that's not always so. The philosophy of design for permanent assembly can become a juggernaut, running over any consideration of maintenance problems. Assemblies that should be easy to maintain–because maintenance is necessary–are designed so replacement of components is possible only with special tools, if at all. There is little or no consideration of the possible frequency of part replacement.

We've had exasperating evidence of this trend in our automobiles, appliances and tools. Now reliability engineering puts the finger on over-design, points up the importance of preventive maintenance, argues for simplicity and reduction of parts.

It can, however, backfire in accentuating the trend to non-maintainable products. It can–and will–cause design in which no consideration is given to the possibility that the user can maintain it or to the possibility that service men are becoming less, rather than more, competent.

Perhaps my point can be illustrated by the remark a garageman made a number of years ago. I had one of the last of the Willys Knights, on which I lavished a great deal of weekend care. But once I goofed and had to call in the garageman–an old Willys Knight expert–to get the engine running again. His remark: "If you'll let me weld down the hood so you can't get at it, I'll guarantee the sweetest-running engine you ever had."

His basic argument was sound–as long as he was within call. But I'd be almost certain to have trouble some time far away from home. Then I'd *better* know what to do—and be able to do it.

He was going to assure reliability by making a non-maintainable assembly. Much the same reasoning is applied in present designs–seal the assembly so trouble can't get at it. Trouble, however, also laughs at locksmiths. Sooner or later, maintenance will become necessary. Then the design had better have allowed for it, or the maintenance may hurt more than it helps.

If every design were a "one-hoss shay," so every part was as strong as every other, maintainability would be no potential problem. Most users would settle for a good deal less than 100 years of use—if it could all be troublefree. But it won't be, can't be.

So we'd better learn to consider maintainability, too.

R. S. Langeman

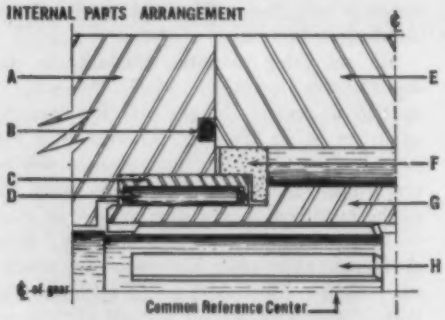
COMMERCIAL Announces...

A Remarkable New Fluid Power Pump

COMMERCIAL presents the new, Series 15H fluid power pump—a logical extension of its Series 36H line which has received such outstanding acceptance. This small powerhouse possesses all the proven basic features of the larger COMMERCIAL fixed displacement gear pump but is designed for those applications where flow requirements are less. The Series 15H is made in ½", ¾", 1", 1¼", 1½", 1¾" and 2" gear widths and covers a delivery range from 3 to 15 gpm at 1200 rpm. It is recommended for continuous duty operation at pressures up to 2000 psi—at speeds up to 2400 rpm. Volumetric and mechanical efficiency rate over 90%. 15H pumps are available for flange or pad mountings of many styles and can be furnished with ports to accept tapered thread, straight thread or SAE split flange fittings.

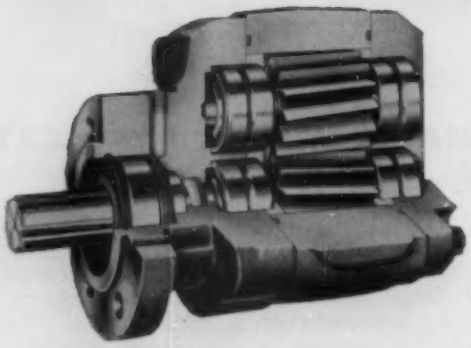
High performance for keeps

Perfect alignment is "built in" these pumps because of their unique basic construction which establishes the machining of all internal parts from one common reference, the gear center line. (See drawing.)



A-bearing carrier
B-"O"ring seal
C-bearing outer race
D-bearing roller
E-gear housing
F-floating thrust plate
G-gear
H-drive shaft spline

As shown, gear bearings also act as dowels—outmoded dowel pins are eliminated.

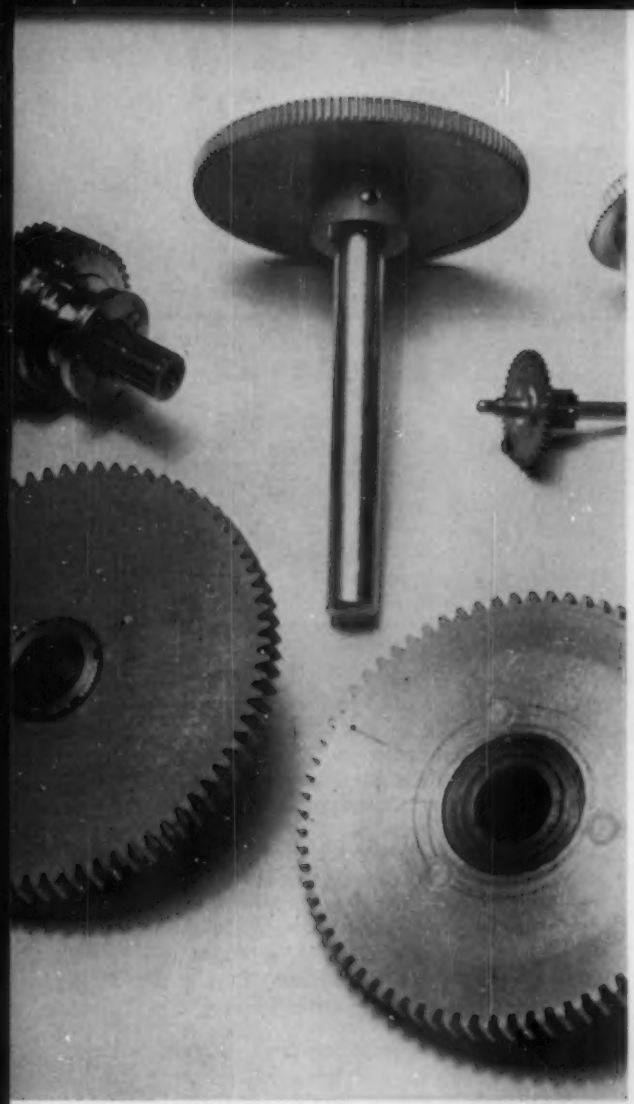


Matched helical gears having mirror finish ground on all surfaces contribute to high volumetric efficiency and quiet operation. Thus, complete sealing is maintained—tooth to tooth and tooth to gear housing. Ruggedness, greater load capacity and dampening of unbalanced internal loading are assured by using integral gear hubs to serve as journals for the pump's oversize gear bearings. In order to meet its own exacting standards, COMMERCIAL must, and does, produce its own gears.

A dynamic seal is maintained between gear faces and special bronze alloy gear thrust plates. The entire thrust plate "closes in" against the gear face because of pressure pocketed behind the plate, thus compensating for any wear on its gear contact surface. Because the sealing area is confined to a small portion of the contact surface, the amount of friction has no appreciable effect on pump mechanical efficiency.

Engineering experience available—personal technical service and assistance is yours for the asking. For more information write to Commercial Shearing & Stamping Company, Dept. G-23, Youngstown 1, Ohio.

COMMERCIAL
shearing & stamping



15 ways to FASTEN GEARS TO SHAFTS

So you've designed or selected a good set of gears for your unit—now how do you fasten them to their shafts? Here's a roundup of methods—some old, some new—with a comparison table to help make the choice.

L M RICH, *project engineer, Librascope Inc, Glendale, Calif*

1 PINNING

Pinning of gears to shafts is still considered one of the most positive methods. Various types can be used: dowel, taper, grooved, roll pin or spiral pin. These pins cross through shaft (A) or are parallel (B). Latter method requires shoulder and retaining ring to prevent end play, but allows quick removal. Pin can be designed to shear when gear is overloaded.

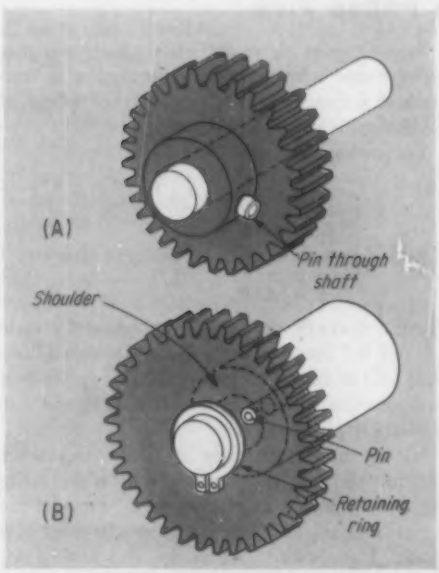
Main drawbacks to pinning are: Pinning reduces the shaft cross-section; difficulty in reorienting the gear once it is pinned; problem of drilling the pin holes if gears are hardened.

Recommended practices are:

- For good concentricity keep a maximum clearance of 0.0002 to 0.0003 in. between bore and shaft.
- Use steel pins regardless of gear material. Hold gear in place on shaft by a setscrew during machining.
- Pin dia should never be larger than ⅓ the shaft—recommended size is 0.20 D to 0.25 D.
- Simplified formula for torque capacity T of a pinned gear is:

$$T = 0.787\,Sd^2D$$

where S is safe shear stress and d is pin mean diameter.



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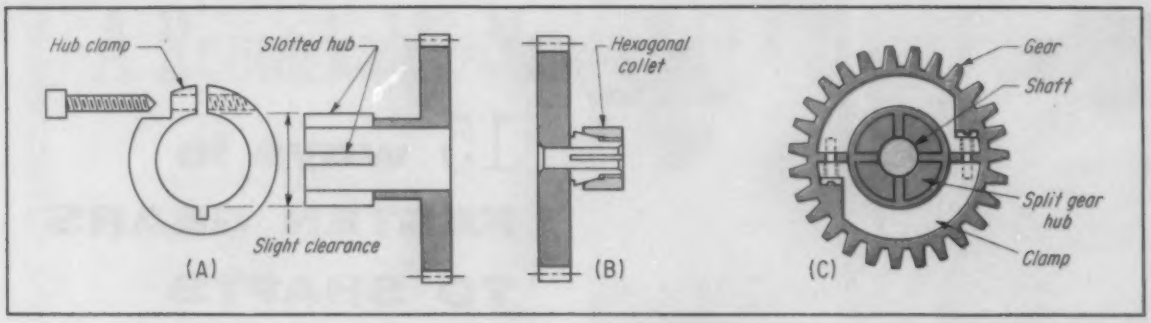
2 CLAMPS AND COLLETS



Clamping is popular with instrument-gear users because these gears can be purchased or manufactured with clamp-type hubs that are machined integrally as part of the gear (A), or pressed into the gear bore. Gears are also available with a collet-hub assembly (B). Clamps can be obtained as a separate item.

Clamps of one-piece construction can break under excessive clamping pressure; hence the preference for the two-piece clamp (C). This places the stress onto the screw threads which hold the clamp together, avoiding possible fracture of the clamp itself. Hub of the gear should be slotted into three or four equal segments, with a thin wall section to reduce the size of the clamp. Hardened gears can be suitably fastened with clamps, but hub of the gear should be slotted prior to hardening.

Other recommendations are: Make gear hub approximately same length as for a pinned gear; slot through to the gear face at approximately 90° spacing. While clamps can fasten a gear on a splined shaft, results are best if both shaft and bore are smooth. If both splined, clamp then keeps gear from moving laterally.

Material of clamp should be same as for the gear, especially in military equipment because of specifications on dissimilarity of metals. However, if weight is a factor, aluminum-alloy clamps are effective. Cost of the clamp and slitting the gear hub are relatively low.

3 PRESS FITS

Press-fit gears to shafts when shafts are too small for keyways and where torque transmission is relatively low. Method is inexpensive but impractical where adjustments or disassemblies are expected.

Torque capacity is:

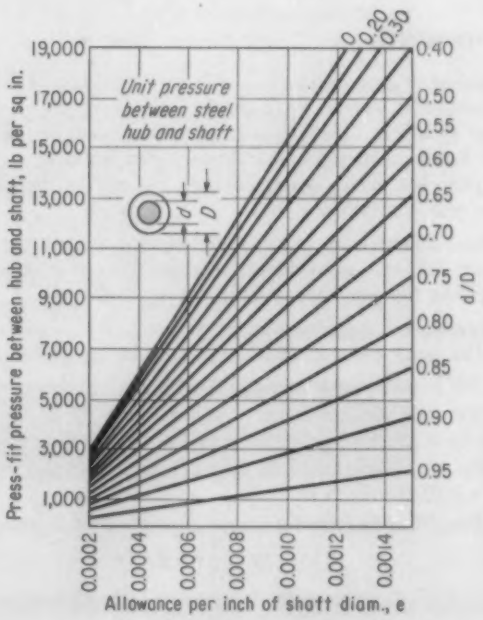
$$T = 0.785\, f D_1 L e E \left[1 - \left(\frac{D_1}{D_2}\right)^2\right]$$

Resulting tensile stress in the gear bore is:

$$S = eE/D_1$$

where f = coefficient of friction (generally varies between 0.1 and 0.2 for small metal assemblies), D_1 is shaft dia, D_2 is OD of gear, L is gear width, e is press fit (difference in dimension between bore and shaft), and E is modulus of elasticity.

Similar metals (usually stainless steel when used in instruments) are recommended to avoid difficulties arising from changes in temperature. Press-fit pressures between steel hub and shaft are shown in chart at right (from Marks' Handbook). Curves are also applicable to hollow shafts, providing d is not over 0.25 D.



COMPARISON OF GEAR-FASTENING METHODS

Method	Torque Capacity	Ease of Replacing Gear	Reliability Under Operation	Versatility in Applications	Ability to Meet Environment Specs	Machining Requirements	Ability to Use Prehardened Parts	Relative Cost
1—Pinning	Excellent	Poor	Excellent	Excellent	Excellent	High	Poor	High
2—Clamping	Good	Excellent	Fair	Fair	Good	Moderate	Excellent	Medium
3—Press fits	Fair	Fair	Good	Fair	Good	Moderate	Excellent	Medium
4—Loctite	Good	Good	Good	Excellent	Excellent	Little	Excellent	Low
5—Setscrews	Fair	Excellent	Poor	Good	Fair	Moderate	Good	Low
6—Splining	Excellent	Excellent	Excellent	Fair	Excellent	High	Excellent	High
7—Integral shaft	Excellent	Poor	Excellent	Good	Excellent	High	Excellent	High
8—Knurling	Good	Poor	Good	Poor	Good	Moderate	Poor	Medium
9—Keying	Excellent	Excellent	Excellent	Poor	Excellent	High	Excellent	High
10—Staking	Poor	Fair	Poor	Poor	Good	Moderate	Poor	Low
11—Spring washer	Poor	Excellent	Good	Fair	Good	Moderate	Excellent	Medium
12—Tapered shaft	Excellent	Excellent	Excellent	Good	Excellent	High	Excellent	High
13—Tapered rings	Good	Excellent	Good	Excellent	Good	Moderate	Excellent	Medium
14—Tapered bushing	Excellent	Excellent	Excellent	Good	Good	Moderate	Excellent	High
15—Die-cast assembly	Good	Poor	Good	Excellent	Good	Little	Fair	Low

4 RETAINING COMPOUNDS

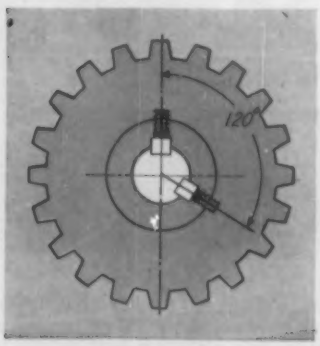
Several different compounds can fasten the gear onto the shaft—one in particular is "Loctite," manufactured by American Sealants Co. This material remains liquid as long as it is exposed to air, but hardens when confined between closely fitting metal parts, such as with close fits or bolts threaded into nuts. (Military spec MIL-S-40083 approves the use of retaining compounds).

Loctite sealant is supplied in several grades of shear strength. The grade, coupled with the contact area, determines the torque that can be transmitted. For example: with a gear ¾ in. long on a ⅞-in.-dia shaft, the bonded area is 0.22 in.² Using Loctite A with a shear strength of 1000 psi, the retaining force is 20 in.-lb.

Loctite will wick into a space 0.0001 in. or less and fill a clearance up to 0.010 in. It requires about 6 hr to harden, 10 min. with activator or 2 min. if heat is applied. Sometimes a setscrew in the hub is needed to position the gear accurately and permanently until the sealant has been completely cured.

Gears can be easily removed from a shaft or adjusted on the shaft by forcibly breaking the bond and then reapplying the sealant after the new position is determined. It will hold any metal to any other metal. Cost is low in comparison to other methods because extra machining and tolerances can be eased.

5 Setscrews



Two setscrews at 90° or 120° to each other are usually sufficient to hold a gear firmly to a shaft. More security results with a flat on the shaft, which prevents the shaft from being marred. Flats give added torque capacity and are helpful for frequent disassembly. Sealants applied on setscrews prevent loosening during vibration.

6 GEARS INTEGRAL WITH SHAFT

Fabricating a gear and shaft from the same material is sometimes economical with small gears where cost of machining shaft from OD of gear is not prohibitive. Method is also used when die-cast blanks are feasible or when space limitations are severe and there is no room for gear hubs. No limit to the amount of torque which can be resisted—usually gear teeth will shear before any other damage takes place.

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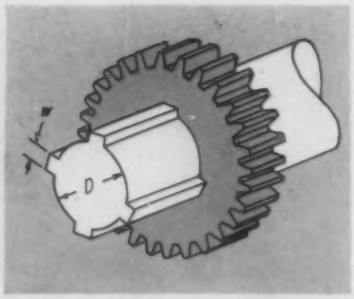
7 SPLINED SHAFTS

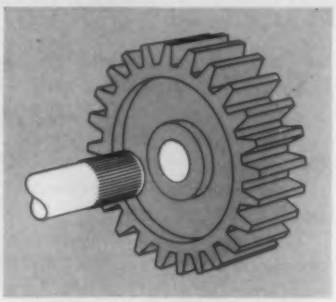


	4-spline	6-spline
D	W	W
1/2	0.120	0.125
3/4	0.181	0.188
7/8	0.211	0.219
1	0.241	0.250
1-1/4	0.301	0.313

Ideal where gear must slide in lateral direction during rotation. Square splines often used, but involute splines are self-centering and stronger. Non-sliding gears are pinned or held by threaded nut or retaining ring.

Torque strength is high and dependent on number of splines employed. Use these recommended dimensions for width of square tooth for 4-spline and 6-spline systems; although other spline systems are sometimes used. Stainless steel shafts and gears are recommended. Avoid dissimilar metals or aluminum. Relative cost is high.

8 KNURLING

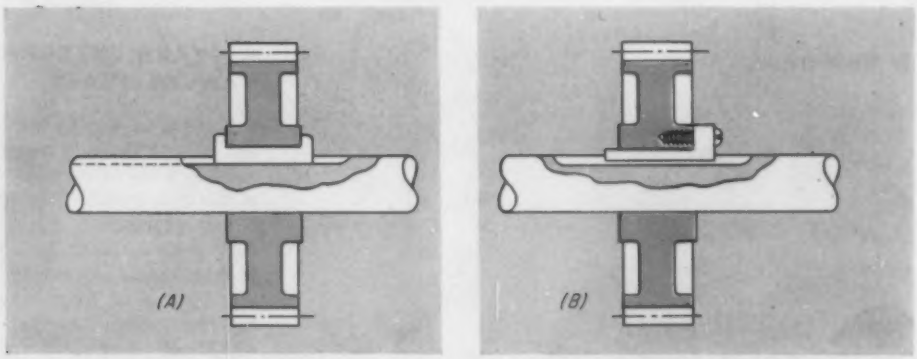


A knurled shaft can be pressed into the gear bore, to do its own broaching, thus keying itself into a close-fitting hole. This avoids need for supplementary locking devices such as lock rings and threaded nuts.

The method is applied to shafts ¼ in. or under and does not weaken or distort parts by the machining of grooves or holes. It is inexpensive and requires no extra parts.

Knurling increases shaft dia by 0.002 to 0.005 in. It is recommended that a chip groove be cut at the trailing edge of the knurl. Tight tolerances on shaft and bore dia are not needed unless good concentricity is a requirement. The unit can be designed to slip under a specific load—hence acting as a safety device. See "Small Shaft Becomes Its Own Broach for Retaining Gears," Feb 2, '59, p 47.

9 KEYING

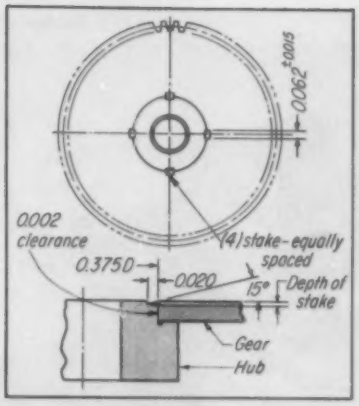


Generally employed with large gears, but occasionally considered for small gears in instruments. Feather key (A) allows axial movement but keying must be milled to end of shaft. For blind keyway (B), use setscrew against the key, but method permits locating the gear anywhere along length of shaft.

Keyed gears can withstand high torque, much more than the pinned or knurled shaft and, at times, more than the splined shafts because the key extends well into both the shaft and gear bore. Torque capacity is comparable with that of the integral gear and shaft. Maintenance is easy because the key can be removed while the gear remains in the system.

Materials for gear, shaft and key should be similar, preferably steel. Larger gears can be either cast or forged, and the key either hot- or cold-rolled steel. However, in instrument gears, stainless steel is required for most applications. Avoid aluminum gears and keys.

10 STAKING



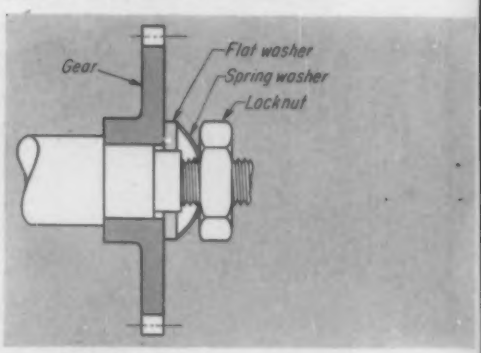
No. of stakes	Depth	Clearance	Torque in.-lb
4	0015	0.0020	27
4	0.015	0.0025	20
4	0.020	0.0020	28
4	0.020	0.0020	30
8	0.020	0	52

It is difficult to predict the strength of a staked joint—but it is a quick and economical method when the gear is positioned at the end of the shaft.

Results from five tests we made on gears staked on 0.375-in. hubs are shown here with typical notations for specifying staking on an assembly drawing. Staking was done with a 0.062-in. punch having a 15° bevel. Variables in the test were: depth of stake, number of stakes, and clearance between hub and gear. Breakaway torque ranged from 20 to 52 in.-lb.

Replacing a gear is not simple with this method because the shaft is mutilated by the staking. But production costs are low.

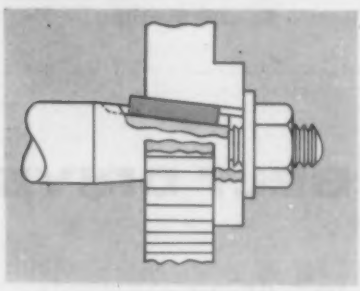
11 SPRING WASHER



Assembly consists of locknut, spring washer, flat washer and gear. The locknut is adjusted to apply a predetermined retaining force to the gear. This permits the gear to slip when overloaded—hence avoiding gear breakage or protecting the drive motor from overheating.

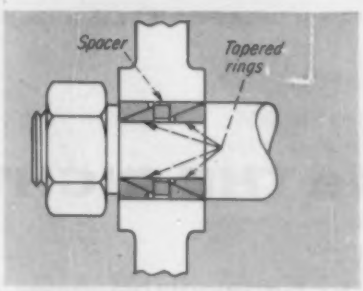
Construction is simple and costs less than if a slip clutch is employed. Popular in breadboard models.

12 TAPERED SHAFT



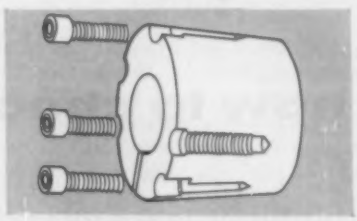
Tapered shaft and matching taper in gear bore need key to provide high torque resistance, and threaded nut to tighten gear onto taper. Expensive but suitable for larger gear applications where rigidity, concentricity and easy disassembly are important. A larger dia shaft is needed than with other methods. Space can be problem because of protruding threaded end. Keep nut tight.

13 TAPERED RINGS



These interlock and expand when tightened to lock gear on shaft. A purchased item, the rings are quick and easy to use, and do not need close tolerance on bore or shaft. No special machining is required and torque capacity is fairly high. If lock washer is employed, the gear can be adjusted to slip at predetermined torque.

14 TAPERED BUSHINGS



This, too, is a purchased item—but generally restricted to shaft diameters ¼ in. and over. Adapters available for untapered bores of gears. Unthreaded half-holes in bushing align with threaded half-holes in gear bore. Screw pulls bushing into bore, also prevents rotational slippage of gear under load.

15 DIE-CAST HUB

Die-casting machines are available, which automatically assemble and position gear on shaft, then die-cast a metal hub on both sides of gear for retention. Method can replace staked assembly. Gears are fed by hopper, shafts by magazine. Method maintains good tolerances on gear wobble, concentricity and location. For high-production applications. Costs are low once dies are made.

EDITOR'S NOTE: For more information on this subject, see:

14 Ways to Fasten Hubs to Shafts, Aug '57, p 194.

REPRINT COPIES of this report are available for 25 cents each by addressing Reader Service Dept., Product Engineering, 330 W 42nd St, New York 36, NY.

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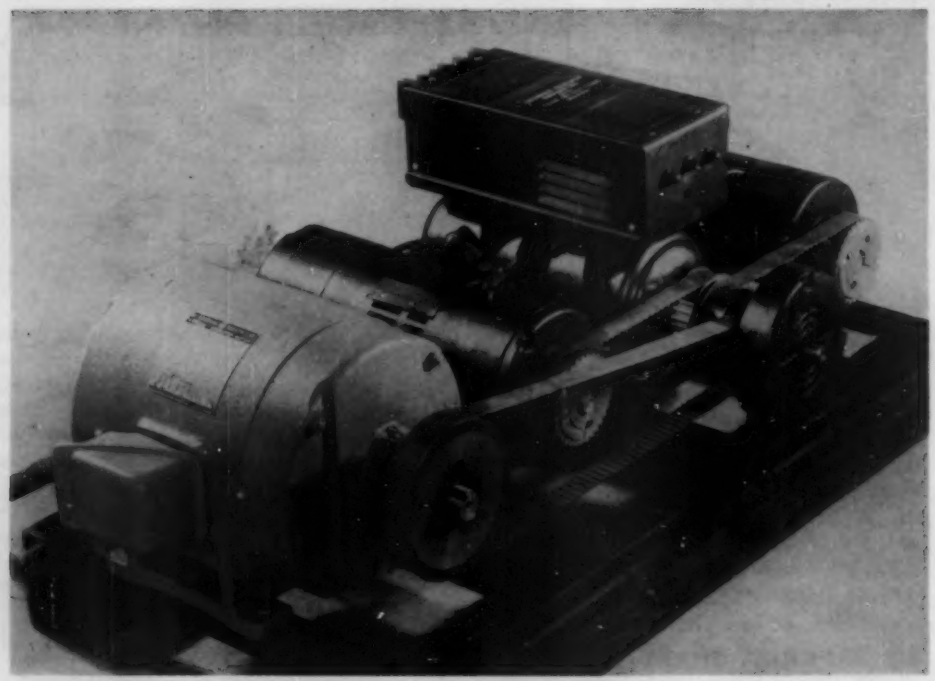


Three positive-drive belts are used in this TV projection machine to synchronize operation.

how to choose THE RIGHT BELT DRIVE

An up-to-date evaluation of the available types of belt drives—with a summary of their operating characteristics.

HARRY W GORDON
Mechanical Power Transmission Dept
Worthington Corp, Oil City, Penna

The trend is toward smaller, more-compact drives that can transmit more power at higher speeds. Evidence of this is the development of the toothed positive-drive belts, the V-ribbed flat belts, and the higher capacity "premium" quality V-belts—including arched and wedged types.

In spite of many variations there are five distinct types: ordinary flat belt, V-belt, link-type V-belt, positive-drive belt, and ribbed V-belt. Here are their characteristics, advantages and disadvantages.

FLAT BELTS

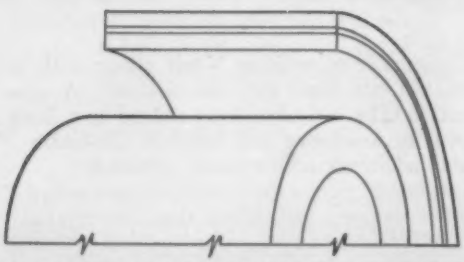
This is the oldest. It depends upon friction to transfer power from driving pulley to belt and, in turn, from belt to driven pulley. It therefore requires high tension and consequently high bearing loads.

Automatic tension devices are necessary with machines depending on the belt for continuous drive. Too high tension in the belt causes unnecessarily high bearing loads; too low tension permits belt slippage. Best way to adjust belt tension is to mount the driver pulley on a motor with a slide rail or pivoted base. Idler pulleys for adjusting tension should be avoided because they put a reverse bend on the belt.

Arc of contact is a factor in developing proper tension. Flat belts require a relatively large arc; therefore larger

COMPARISON OF FIVE V-BELT TYPES

	FLAT BELT	ORDINARY V-BELT	LINK-TYPE V-BELT	POSITIVE-DRIVE BELT	V-RIBBED FLAT BELT
TENSION-BEARING LOADS	Highest	Low	Low	Lowest	High
BEST OPERATING RANGE, fpm	1000 to 10,000	1000 to 6000	1000 to 5000	1000 to 10,000	1000 to 6000
PERFORMANCE ABOVE 5000 fpm	Good	Fair	Not recommended	Good	Fair
PERFORMANCE BELOW 1000 fpm	Fair	Fair	Fair	Good	Fair
RESISTANCE TO SHOCK LOADS	Good	Good	Good	Fair	Good
MECHANICAL EFFICIENCY	Good	Good	Good	Best	Good
EASE OF BELT SPLICE	Good in some types	Good in some types	Excellent	(Endless belt)	(Endless belt)
MISALIGNMENT TOLERANCE	None	Compensates best	Compensates best	None	None
MINIMUM DOWNTIME	Good	Best	Best	Good	Good
NOISINESS	Most	Very Little	Little	Little	Little
SYNCHRONIZES OPERATIONS	No	No	No	Yes	No
CREEP	Some	Negligible	Some	None	Some
INITIAL COST	Low	Low	Low	Moderate	Moderate
RESISTANCE TO WEATHER	Good	Good	Fair	Good	Good
MAINTENANCE NEEDED	Some	Negligible	Some	Negligible	Some



FLAT BELTS OFFER STRENGTH with simplicity. Here, polymer is sandwiched between two leather strips—one, vegetable-tanned; the other, mineral-tanned.

space requirements, and auxiliary idler pulleys. Another limitation closely related to degree of tension and the arc of contact is the noise level, particularly on long center drives. However, short centers can be used with pivoted motor base, provided bearing loads are not excessive.

Advantages of the flat belts are imposing enough, however, to make them competitive with V-belts for many applications. These advantages are:

- Inherent simplicity.
- Low first cost.
- High efficiency.
- Applicability to very high speeds and wide horsepower ranges.
- Ability to flex over small-diameter pulleys and still retain long life.
- Resistance to extremely dusty conditions.

Materials and relative dimensions of belt and pulley are important in weighing the advantages and disadvantages. For example, belt life in flexing is directly proportional to the sixth power of the small-pulley diameter and the first power of the belt length. This shows that a small increase in pulley dia increases belt life considerably. Belt life also varies inversely as the square root of the belt speed, the sixth power of the belt thickness, and the fourth power of the unit tight-side tension. Consequently, the last two factors must be carefully considered in terms of desired length of service. Each manufacturer has his own empirical version of the above factors—in the form of tables and charts for easy selection.

Pulleys for flat belts are most often cast iron, steel or wood, and usually are crowned in accordance with well-established formulas (see Editor's Note).

Leather, rubberized fabric and cord are the base materials for flat belts. Both rubber and leather in a variety of designs are available for operation in adverse conditions —oil, heat, static electricity and moisture. All such conditions reduce coefficient of friction, cause the belt to slip and wear excessively.

1. **Leather belts** derive their transmission characteristics from the quality of the raw product, the nature of the tanning process, and the mechanical design features. Best-quality belts are made from the butt end of steer hides (section along both sides of animal's backbone). Vegetable-

tanning, which is most economical, gives good coefficient of friction and pliability after some use; while mineral-tanning provides these desirable features right at the start. Best leather belts use a combination of both types. For example, vegetable-tanned ply is sometimes bonded to a mineral-tanned ply.

Mechanical design features of the belt cross-section vary with the manner in which the belts are formed into single, double or multiple layers and combined with other materials such as cords, fabric and polymers. Leather belts are also formed in links for heavy slow-speed drives with high slippage characteristics.

2. **Flat rubber belts** are made from fabric or cord impregnated with natural or synthetic rubber compounds. These give varying degrees of strength, stretch, pulley grip, and protection against abrasion, oil and moisture.

3. **Flat fabric belts** are made from 3 to 12 plies, depending on width. The fabric can be cotton or synthetic fiber with or without rubber impregnation. Load and speed characteristics are moderate. Such belts are usually supplied endless; straight lengths can also be spliced in the field.

4. **Flat cord belts** are made from cotton or synthetic material, and are usually supplied endless. They are generally heavy-duty belts used for high-speed, small-pulley and shock-load applications. Steel-cable belts can serve similarly; they have higher capacity and lower stretch than cord constructions.

V-BELTS

Its wedging action against sides of a sheave groove is the outstanding feature, whatever its design. Increase in pull or load results in tighter belt grip against the sheave sidewall. General advantages of these belts:

- Wedging action permits a lower arc of contact on small pulley and a large speed ratio.
- Shorter center distances can be employed for compactness and use of streamlined belt guards.
- Shock-absorbing qualities cushion motor and bearings against load fluctuations.
- Maintenance is at a minimum.
- Vibration and noise levels are low.
- Replacements are quick and easy.
- Power transmission efficiency is as high as 98%.

V-belts are limited, with 600 few exceptions, to a practical speed range of 1000 to 6000 fpm. Some manufacturers recommend 4500 fpm as the most efficient speed. Special drives can be designed for 6000 fpm or more, but sheaves here require dynamic balancing to minimize effect of centrifugal force. Another limitation is the necessity of matching belts in multiple V-belt drives to assure equal distribution of load among all the belts.

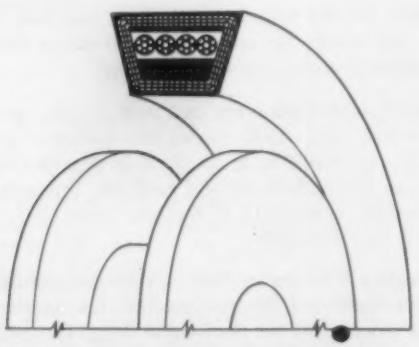
LINK-TYPE V-BELTS

One special variation of the V-belt, the link type, is designed to eliminate need for matching multiple V-belts and to simplify inventory problems. This type has most advantages of the V-belt, except that it is not recommended for speeds over 5000 fpm.

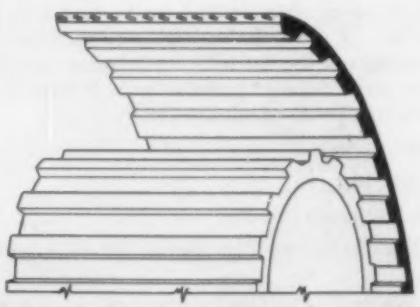
Power ratings recommended by most manufacturers are comparable to ordinary V-belt ratings with normal, heavy, and extra-heavy duty classifications. A minor disadvantage: The individual links add up to a larger area exposed to weathering and moisture absorption. This requires additional rubber-sealing protection.

LINK-TYPE V-BELTS simplify assembly of multiple-belt drives where it would be difficult to match length of each belt, especially on large fixed-center drives.

A recent variation of the V-belt is the wedge-type V-belt, which is narrower and deeper than conventional types. By reducing the rectangular center portion to a minimum, and correspondingly increasing the triangular side portions, the wedge-type V-belt is made more efficient. This makes it possible for three cross-sectional sizes of wedge-type V-belts to cover the same range as five cross-sectional sizes of ordinary V-belts.



V-BELTS COME IN A WIDE VARIETY of sizes and construction features; are long-wearing and reliable.



POSITIVE-DRIVE BELTS combine chain and sprocket action with the simplicity of a flat belt.

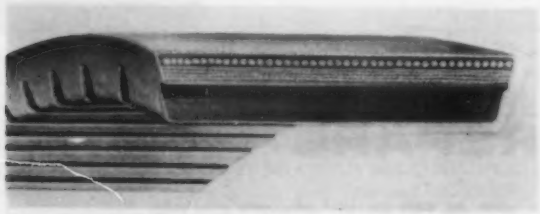
POSITIVE-DRIVE BELTS

This belt is a form of V-belt that incorporates the positive action of a chain-and-sprocket drive with most advantages of the other belt drives. It is essentially a flat belt with teeth, equally spaced on the surface, in contact with a toothed pulley. Continuous, helically wound steel cables are embedded in the belt as the load-carrying element. Neoprene backing and teeth are bonded to the steel cables to provide shear resistance and protection from dust, oil, and moisture.

Actual construction details vary according to manufacturer, but tooth strength generally exceeds the tensile strength of the steel cables when six or more teeth are in mesh.

Like gear-and-chain sprocket drives, this drive requires precise alignment of pulleys and must be made endless. Its advantages are:

- No slippage or speed variation.
- The teeth provide transverse rigidity and longitudinal flexibility, and minimize elongation and necessity for belt take-up.
- Maintenance requirements are negligible.
- Wide range of load and speed, from subfractional horsepower to 60 hp.
- Lowest bearing loads of any belt drive, because of positive tooth action.
- Small pulley, short centers, narrow belts and high capacity add up to minimum space requirements.
- Maximum mechanical efficiency because of inherent elimination of friction, lack of high initial tension, and thin construction.
- High horsepower-to-weight ratio.



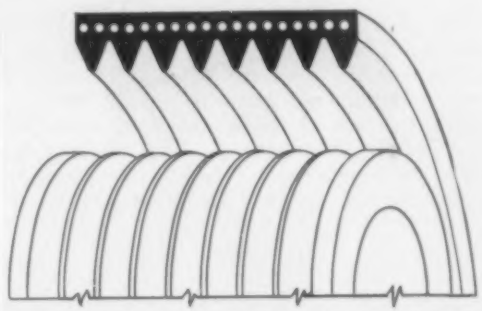
COGGED CONSTRUCTION provides transverse rigidity and lengthwise flexibility needed for variable-speed drives.

Cogged belts are another variation of the V-belt used with variable-speed pulleys. It provides transverse rigidity and lengthwise flexibility, and operates in grooved pulleys just as any other V-belt does; however, its pulleys are made with a split construction which allows one flange of the pulley to be moved along the shaft axis. This motion opens or closes the pulley, causing the belt to ride higher or deeper in the groove, thus giving a variation in pitch within limits of the pulley diameter.

V-RIBBED BELTS

This is the latest outgrowth of the ordinary V-belt. It combines the strength and simplicity of the flat belt with the positive tracking of V-belts. It eliminates the matching problem in multi-V-belts, although sheaves must be grooved to mate precisely with the belt. The pulleys must be precisely aligned. Advantages are:

- Less space required because twice the contact area with half the face pressure gives greater power capacity.
- Effective pitch maintained constant at all loads.
- Longer life for belt and sheaves because of uniform group.
- More effective cooling because of larger contact area between belt and pulleys.



RIBBED BELTS will transmit high loads quietly, and in less space than V-belts.

These units come in two cross-sections: L-section belts find application where A-, B-, or C-section multiple V-belts would be used; M section where C-, D-, or E-belts would be used. Sheaves with tapered bushings are available. Recommended speeds are in the range of 200 to 10,000 fpm for up to 10-hp ratings. Most of the effective applications are on small sheaves and short center distances.

For REPRINT of above article, just check P 53 on one of the Reader Service cards bound in this issue.

EDITOR'S NOTE: For additional information on belts, see:

Flat Belts for Adjustable-pitch Pulleys, Oct 27 '58, p 59—How a segmented flat belt is used for adjustable pulleys.

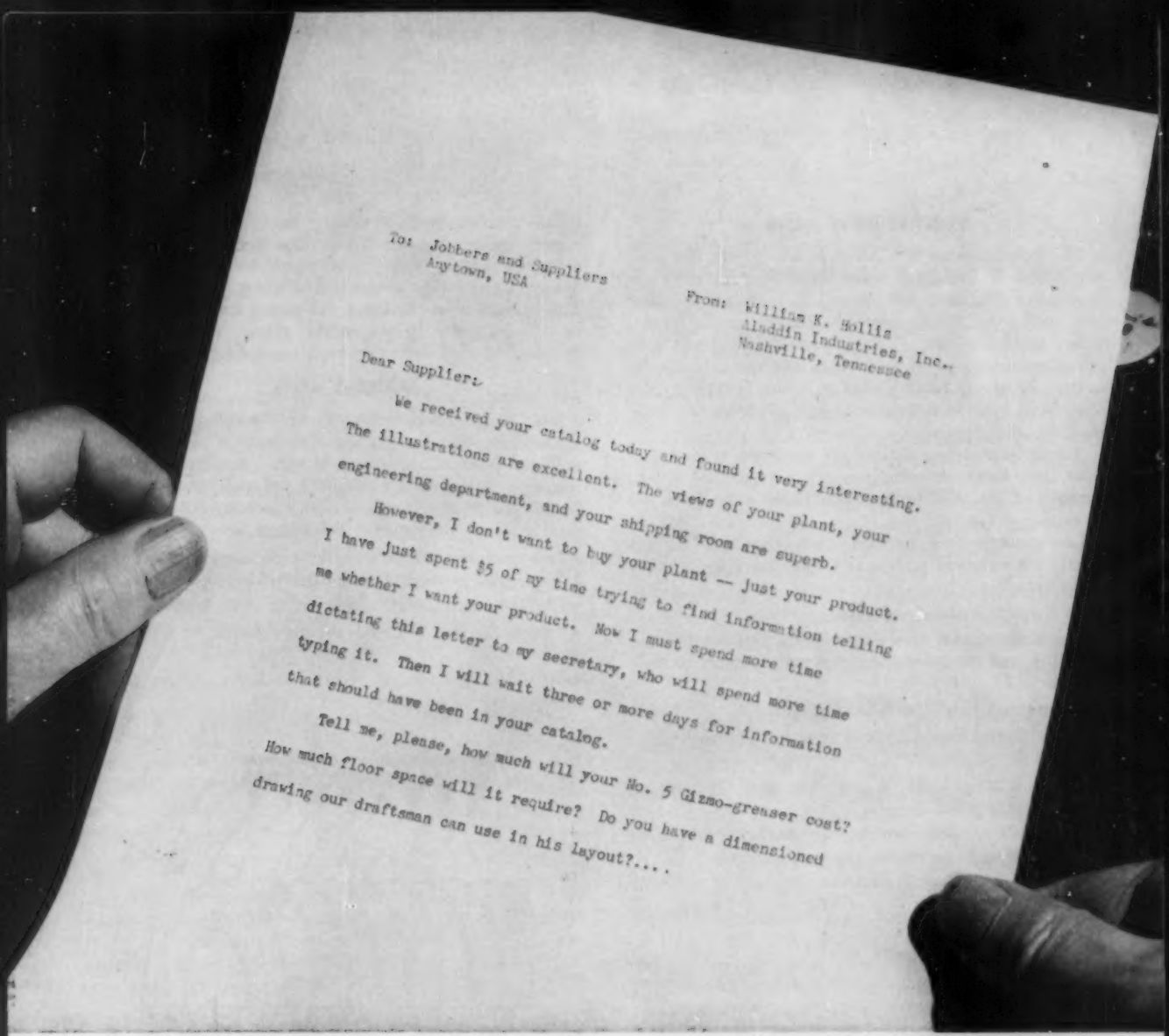
New V-belt Drives for More Power, Apr 13 '59, p 70—Arched type V-belt has three times the horsepower capacity in the same space.

How Much Crown Does a Pulley Need, June '57, p 185—Here is the mathematical relationship between crown, belt tension and pulley misalignment.

Design of V-belt Drives for Mass-produced Machines, Sep '53, p 154—Detailed analysis of factors that affect V-belt applications with particular emphasis on mass-produced machines.

Leather Belts—Hp Loss and Speed, Oct. 14 '57, p 123. For 0-10,000 fpm and 435-3450 rpm with pulley diameters up to 30 in. Data, corrected for centrifugal force, is not found in handbooks.

Ten Types of Belt Drives, May '55, p 172—Diagrams and key pointers show how belt drives can be adapted to solve power-transmission problems.



To: Jobbers and Suppliers
Anytown, USA

From: William K. Hollis
Aladdin Industries, Inc.
Nashville, Tennessee

Dear Supplier:

We received your catalog today and found it very interesting. The illustrations are excellent. The views of your plant, your engineering department, and your shipping room are superb.

However, I don't want to buy your plant — just your product. I have just spent $5 of my time trying to find information telling me whether I want your product. Now I must spend more time dictating this letter to my secretary, who will spend more time typing it. Then I will wait three or more days for information that should have been in your catalog.

Tell me, please, how much will your No. 5 Gizmo-greaser cost? How much floor space will it require? Do you have a dimensioned drawing our draftsman can use in his layout?....

WHY DON'T THEY PREPARE BETTER TECHNICAL CATALOGS?

WILLIAM K HOLLIS
Aladdin Industries Inc
Nashville, Tenn

How many technical catalogs do you receive that deserve such a letter? Too many, no doubt. Those responsible for a poor catalog forget or ignore the prime function of the catalog—to give design, price, and availability information to engineers as quickly and simply as possible.

For examples of good catalogs that do their intended job well, take a look at mail order catalogs such as Montgomery Ward's or Sears, Roebuck and Co's. Pick any item at random and see if the description doesn't cover all information necessary for you to make a decision about buying the item. Not only that, the catalog also tells you how and where to place your order.

Now take a look at some of the technical catalogs you've received recently. If you were asked to rate them, or if

you were asked for some comments on your own company's literature, how would your gripes compare with these?

Inadequate Information

A catalog that can't answer any appropriate question you ask isn't worth space on your shelf. What will the equipment do? How much will it cost? What are its overall dimensions? What are some applications? Ratings? Are some operational or cross-sectional views shown? What other necessary information is missing?

Poor Organization

A catalog full of sub-notes and page references is poorly organized and a waste of your time. For instance, you look for a sprocket and find that type B sprockets for No. 50 chain are listed on page 44. To see what type B sprockets look like, you must turn to page 65. Then a sub-note refers you to page 21, table II, if you want to know what bores are available. Page 17 tells you it can be supplied in steel, brass, or cast iron. You send in your order. Then you receive a letter telling you if you had scanned page 33 you would have noticed that type B sprockets are available for single, double, or triple chain—and which do you prefer?

The Pint-size Trend

Miniaturization has hit the catalog field. You receive a catalog the size of a pocket notebook which is expertly filled with hundreds of postage-stamp-size dimensioned drawings. You can't tell a 3 from an 8 with the naked eye. The type is smaller than the fine print on a contract. Destination: wastebasket.

Limp Literature

Why isn't a little more attention paid to the binding of catalogs? Have you tried to get one of those limp-bound brochures to stand at attention on a shelf? You place it rigidly among its fellows. It soon starts to sag and warp. Sometimes it shyly crawls back in the shelf and hides away. Admittedly, when such a catalog is used at the drawing board it opens nicely and its pages lay flat. We are enthusiastic about spiral bindings when we use the information and so is every layout man who ever had to weight a catalog to hold its pages open. But why doesn't it occur to some genius that a catalog can be spiral-bound and still have a stiff back—so it could stand proudly among its fellows when you set it aside?

1001 Different Sizes

The growing rumblings against conformity are fine—we're all for them. But when it comes to literature intended for filing, let's not lose our heads. We need file-size files. A good portion of the literature we receive is in the form of leaflets and slender catalogs that must be placed in file folders. These folders are letter-size, yet the literature varies from midgets to mammoths—the size of an art calendar. Why can't such information be a uniform 8½ x 11? Better yet, why can't the mechanical field set up a uniform filing system? A filing tab on each leaflet would speed things up, and assure you of being able to find it again when you need it.

All That Frosting . . .

Why is it necessary to show us views of the office, machine shop, a corner of the drafting room, or a closeup of some hairy-armed fellow peering intently at a lathe? Our interest in the product is not particularly stimulated by a picture of the bearded founder, or a composite view of many plants. The company history must be interesting to somebody—maybe its own employes, or management. But somehow we can't take the same personal interest. We don't want a personnel booklet, we want technical information. The purpose of the catalog is to present facts about the product in a concise yet complete manner.

Who and Where?

We've had enough of this: ". . . For lightning service or information contact your nearby Know-all Sales Office or your authorized Know-all distributor." How about the name (or title), address, and telephone number of somebody we can write or call—somebody who can answer technical questions just in case the catalog doesn't have all the answers. This somebody should also be able to tell us about how long it will take to fill an order and what it will cost.

Surprise!

Many catalogs are prepared with just these gripes in mind. They can readily be used, contain all information needed where you can find it, and can stand up on the shelf. These are the catalogs that become our standbys. We refer to them often—thus they serve our purpose and the supplier's. Once in a while when we send for information, we receive a surprise—something extra. One bearing manufacturer sent out a series of full-size drawings which were very useful in layout work. Guess who is considered first when bearings are to be specified? Why doesn't it occur to more parts suppliers that a full-size templet or underlay will be used at the board? Everytime it is used we will be reminded of the company.

EDITOR'S NOTE: For methods of accumulating and handling your personal library, see:

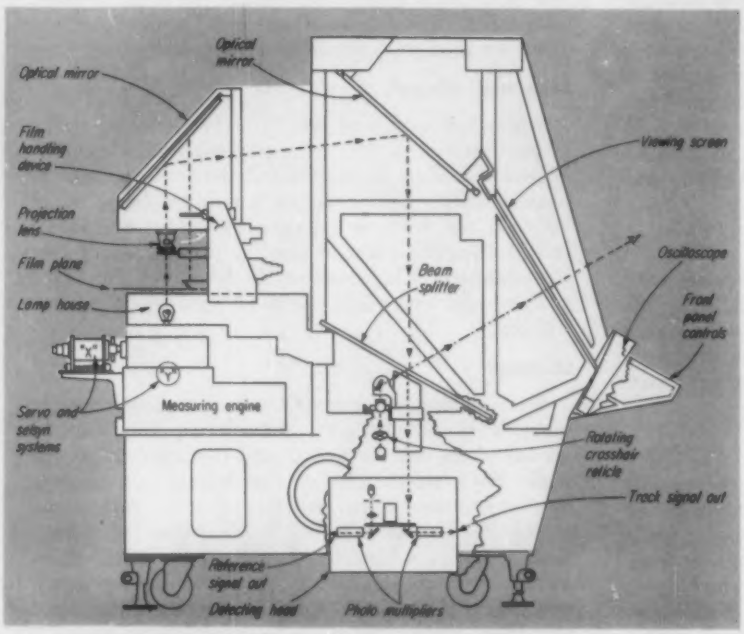
A System for Your Personal File, April 6 '59, p 43. A simple 2-step system for keeping tabs on any kind of subject matter—even if you forget title and author's name.

Filing for Faster Reference, Dec 9 '57, p 82, cautions not to file catalogs alphabetically, and tells how to file by function.

The Engineer's Bookshelf, Mar '57, p 167. A guide for building an engineering library. Suggests how to proceed, and lists a technical bibliography—revised Mar 30, '59.

Here's a way to reconstruct 3-dimensional paths from two or more orthogonal-view photos. Coordinates fed to punched cards can then be processed rapidly, reducing data-analysis time from days to minutes.

Projector Plots Path of Moving Objects



PS . . . Measuring System has three major elements: The measuring projector (described here), the data control desk, and the electronics unit. The system is used to analyze the path of any 3-D motion recorded by two or more photos taken from different locations. In operation, photos of the moving objects are projected on the screen. The operator straddles the image with projected reference marks. The projector can then track the image automatically and record the X-Y coordinates of the path. Punched cards produced by tracking two or more views of the same trace are fed to a computer for rapid analysis and evaluation. The "Frankenstein" projector system is used to analyze the path of atomic particles in a liquid-hydrogen bubble chamber. This system can also be used for quantitative measurements in rocketry, astronomical studies, and aerial survey. Model FR-1 Measuring Projector is produced by Gilliland-NRI, Co, Oakland, Calif.

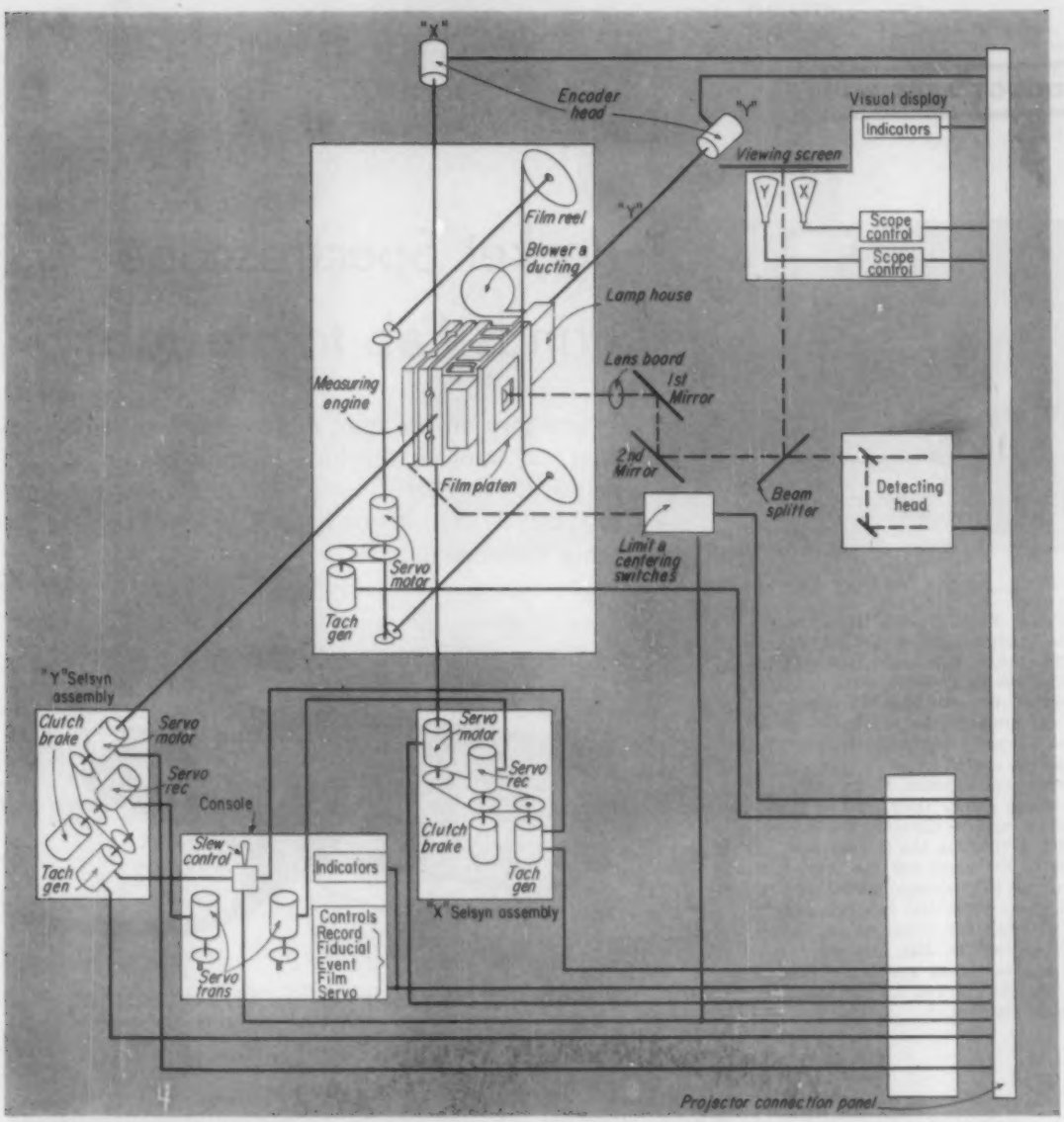
FILM CARRIER supplies the tracking movement; projected reference marks are stationary. Film carrier consists of lightweight glass platens attached to the measuring engine. Three separate films of either 35 or 70mm width can be handled for the various views taken. Only one film frame at a time is projected during actual measurement, however. Film is held by vacuum applied to slots located on the periphery of the platen and transported by vacuum-operated clamps.

Light beams from the lamp house, mounted below the movable film platen, are transmitted vertically through the film and then projected by a front surface mirror system to a beam-splitter. The splitter routes the image to the operator's screen and detecting unit.

The operator sees the film image on a 24 x 28-in. screen and, with an optically projected crosshair, can observe the relative position of the image. The crosshair is aligned in precise agreement with the detecting unit. The film image may be adjusted to the measuring axis (crosshair image), using either the optical or electrical display or both. Rotating the crosshair to straddle the film image rotates the detecting unit to produce the maximum error signal for automatic tracking.

The portion of the image straddled by the crosshair reaches the detecting head through a small aperture. A scanning disk samples the projected area for an image. A sampling rate of 1440 looks per second is achieved by combining a 24-slot scanning disk and a 3600-rpm synchronous motor.

The detecting unit senses the position of the projected image relative to the measuring axis or crosshair. The measuring axis is aligned to fall through the center of the aperture in the detecting head. This area is



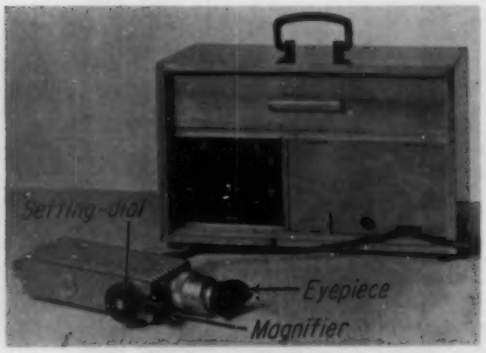
scanned by the slotted scanning disk. When the projected film contains no image the passage of each slot in the scanning disk allows a fixed amount of light to pass. A photomultiplier senses the light admitted during each scan and develops a pulse of length equal to scanning time, and rate equal to the number of slots passing per second.

An image on the film, representing the path of an object in the active detection area, will cause a variation in light intensity falling on the photomultiplier during the scan. This variation produces a signal pulse of opposite polarity to the scanning pulse and combined with it. The signal itself is later extracted by the electronics circuits. A reference pulse is developed during each scan by a separate light-source, narrow radial aperture, and photomultiplier. The reference aperture may be mechanically adjusted relative to the active-area aperture so as to align exactly with the measuring axis. Thus two pulses are developed: A reference marker occurring when the scanner slot passes the measuring axis, and a signal from an image falling within the active area. The time-phase relation between the centers of the two signals is proportional to the off-axis error.

This error signal is processed through a sine/cosine potentiometer, which divides the error signal into X and Y components. This is accomplished by gearing the potentiometer to the scanning-disk assembly and also to the operator's optically projected crosshair. This means that when the crosshair is turned parallel to (or tangent to) a line image, the error signal is optimized by turning the scanning slots parallel to the track they are following. Thus, the total error signal is correctly divided into X and Y components.

Automatic track "lock-on" is provided by applying the X and Y error signals through servo amplifier and motor systems to drive the measuring-engine stage to a null position in both axes. The time constant and "tightness" of the servosystems are such as to permit rapid "lock-on" corrections to be made automatically at full tracking speed without impairing accuracy.

Measuring-engine section of the projector has a traverse of 3 x 5 in. The saddle and stage are supported by ground, double-V ball ways. Motion of the stage is accomplished by lapped, 1-mm-pitch lead screws. They may be driven manually and remotely from the operator's position by the X and Y selsyn drive systems. With automatic operation, they are driven by the servomotors, operating from image-positioning error signals.



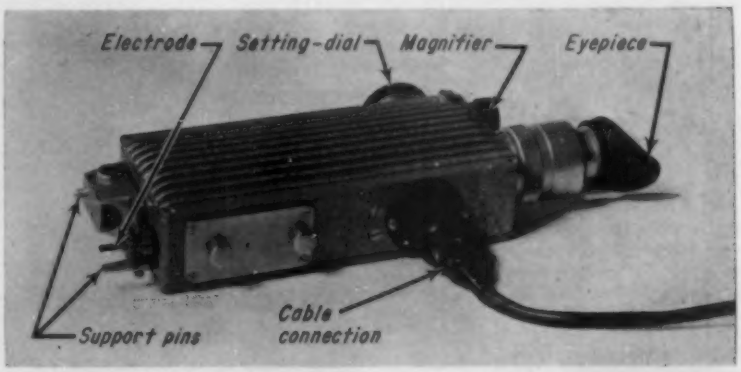
Pocket Spectroscope Brings Lab to the Job

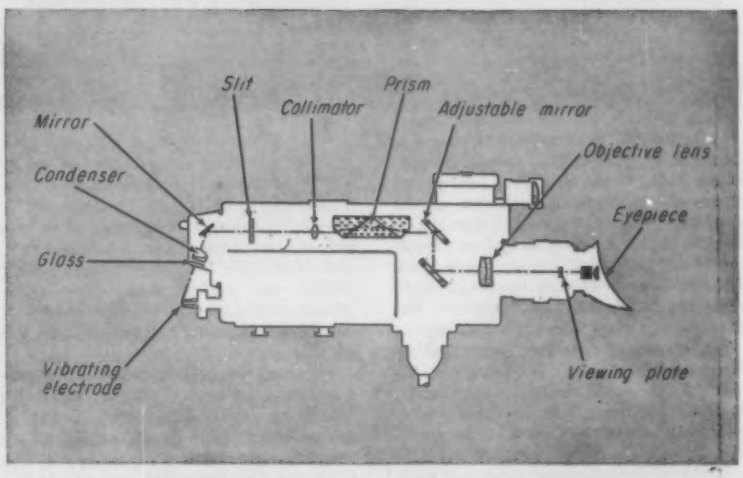
It provides on-the-spot, nondestructive inspection of metal samples, machine components or installed structural work. The safe, low-tension unit can be used inside boilers, pipes or other metal structures.

VIBRATING ELECTRODE is a replaceable tungsten pin 3 mm in dia. Supporting pins act as secondary electrodes and provide a current path when the spectroscope is in use When contact is established, the electrode vibrates at 50 cps to continuously make and break the spark.

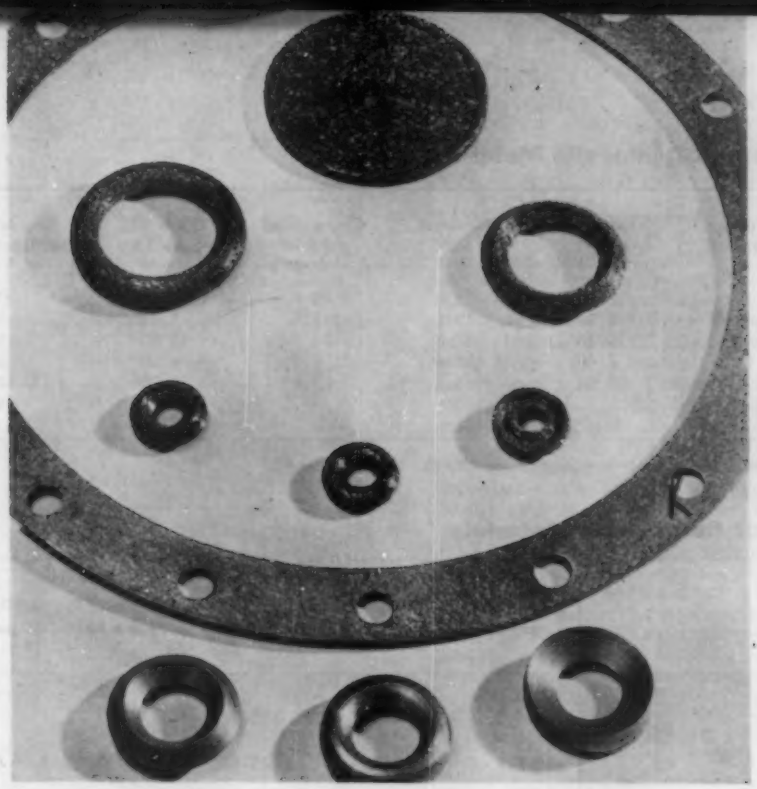
The spectrum appears in an intermedate image plane. Only part of the spectrum is visible through the eyepiece but, by rotating the setting dial, segments of the spectrum are moved past an arrow in the image plane. The scale on the setting dial can be read through a magnifier mounted on the case. By setting the dial, and the arrow, at a preselected spectrum line, samples may be checked for any specific chemical element.

LIGHT PATH starts at the vibrating electrode. The arc is generated between it and the material under investigation. Light emitted by the arc passes through a protective glass plate which prevents the condensing lens from being soiled. The front surface mirror reflects the rays through a 6-micron slit to the collimator. This arrangement of lenses results in the condenser forming an image of the light source in the opening of the collimator. This provides uniform illumination over the length of the slit, and paths of the rays behind the collimator are parallel. Light rays passing through the straight-view prism are separated to form the spectrum. The two mirrors and the objective lens form an image of the spectrum on the glass viewing plate. The adjustable mirror pivots to display a wide range of wavelengths on the plate. An arrow on the plate provides the reference mark for taking readings from the adjustable-mirror setting dial.





PS . . . Low-tension spectroscope permits qualitative analysis of metal alloys and, with practice, broad-scale quantitative analysis is possible. Arc generator produces an electric arc which serves as the light source producing the spectrum for examination. Transformer input is 1.6 amps, 220 v ac; output can be varied by a step switch between 25 and 40 volts. Hand spectroscope model RD-M is produced by VEB Rathenower Optische Werke, Rathenow (D.D.R.), W Germany.



high-temperature static seals from . . .

METAL FIBER COMPOSITES

Impregnating a metal felt with a compatible soft metal gives an unusual material that will seal 5000-psi air at 1000 F. An expert reports on latest developments in a new application for fiber metallurgy.

M SABANAS, *research engineer*
Armour Research Foundation, Illinois Institute of Technology

A good static seal material for high-temperature, high-pressure service requires an unusual array of properties. Along with resilience, compressibility under moderate load, and recovery upon load release, such a material must offer zero porosity when compressed, and resistance to the latest industrial fluids. At 1000 F and above, metallic composites are the only materials that have these properties. Here are latest data on this new series of hybrids—hard metal-fiber felts impregnated with soft metals or polymers.

Where They Come From

The idea of such composites stems from a common technique—gaining resilience by incorporating springs in high-temperature seal designs. Similar spring action is given to the sealants by using a felting process to give a skeleton structure of metal fibers. This fiber metallurgy produces porous skeletons that can be used in either the loose, as-felted condition or bonded for greater strength by sintering or brazing. The rigid skeletons thus produced (see photo above) can be tailored to have densities from 5 to 95% of the solid parent material. Stainless steel and molybdenum, in fibers from 4 to 8 mils in diameter and ½ to ¾ in. long, are the most common skeletal materials so far.

Impregnating the fiber skeletons with a second material gives two completely interpenetrating, continuous phases—like a sponge within a sponge. Since both phases are continuous, this allows combining the properties of each. Thus a continuous rigid phase, such as stainless or molybdenum, offers maximum support to a continuous conforming phase, like silver or tin. Properties of the composite can be varied considerably by changing the constituents and fabrication methods. For example, strength can be improved by bonding the skeleton fibers, densifying the skeleton, and impregnating with a higher-modulus material. It is possible to have this higher strength with

Table I—Properties of Six Composite Metal Seals

No.	Composition, % by volume Skeleton	Impregnant	Density gm/cc	Hardness, BHN	Comp. Mod. psi x 10^6	0.2% YS, psi x 10^3	Max temp. for 5000-psi seal, °F
1	18.5 Mo	81.5 Tin	7.80	15.8	10.0	5.80	250
2	60.0 Mo	40.0 Indium	8.98	13.0	1.1	1.13	120
3	39.4 Mo	60.6 Silver	10.36	67.3	14.0	15.80	1200
4	39.0 SS*	61.0 Tin	7.46	23.4	7.1	4.00	250
5	26.9 SS	73.1 Mg	3.63	46.7	13.6	25.00	1000
6	47.0 SS	53.0 $(PNCl_2)_n$**	.....	.....	.....	.....	820

* Type 430; ** Polyphosphonitrillic chloride, properties of composite as yet undetermined.

Table II—Properties of Component Materials

	Material	Density, gm/cc	Melting Pt, °F	Hardness, BHN	Modulus E, psi x 10^6	0.2% Yield Str psi x 10^3
Skeleton	Molybdenum	10.2	4750	160–185	50.0	57
	Type 430 stainless	7.7	2600	145–185	29.0	40–55
Impregnant	Indium	7.3	220	0.90	1.6	0.38
	Tin	7.3	450	5.86	6.0	1.25
	Magnesium	1.7	1200	30.0	6.5	3.00
	Silver	10.5	1760	32.6	11.0	7.90
	Polyphospho-nitrillic chloride	*	250	*	*	*

* Properties undetermined as yet, similar to silicon elastomers.

Table III—Recovery Properties of Composites

(Sample Nos. correspond to Table I)

Sample No.	1% Deformation Stress, psi	Recovery, %	2% Deformation Stress, psi	Recovery, %	5% Deformation Stress, psi	Recovery, %	10% Deformation Stress, psi	Recovery, %
1	2,826	72	7,812	63	11,841	23	15,660	13
2	611	59	2,673	46	12,426	32	22,918	14
3	4,761	71	8,607	49	11,637	23	12,732	13
4	9,116	89	28,367	62	40,437	30	52,560	12
5	9,167	87	19,098	62	27,247	31	34,988	19

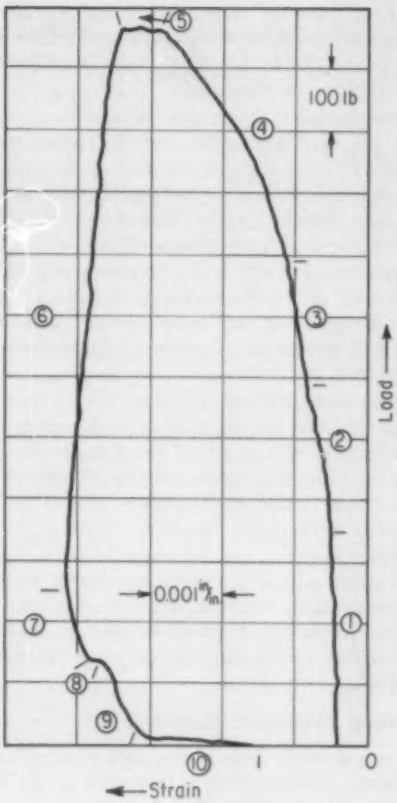
but minimum loss of conformability and resilience. For service at higher temperature, an impregnant with higher melting point would be chosen.

Their Performance

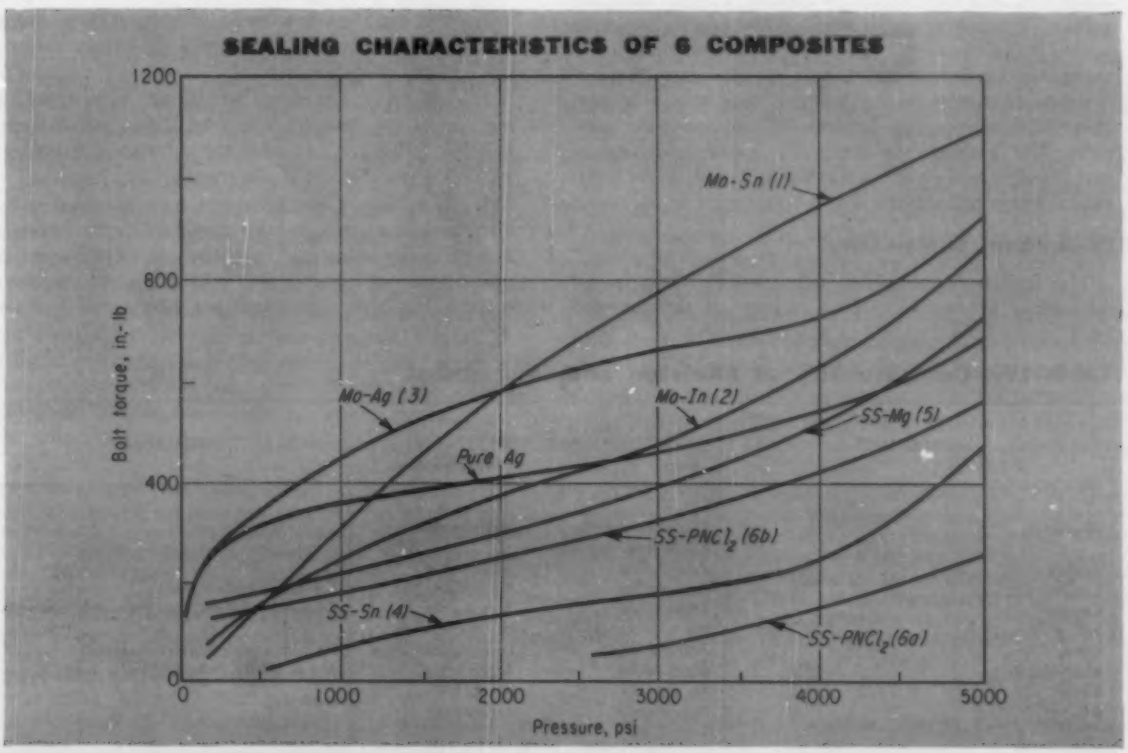
How do composite inorganic seal materials behave under compression? Under temperature? Under fluid pressure? Tentative answers to these questions are available based on experiments with a limited number of skeleton-impregnant combinations. Table I summarizes the properties of these six composites as determined from compression tests and static-seal tests. For comparison, properties of the individual component materials appear in Table II. Note that the composites do not acquire properties from the individual constituents in proportion to the amount of the constituent present. Composite No. 3, for example, has 39% molybdenum—a high-strength skeletal material—yet its strength is barely double that of the impregnant.

Compression modulus and offset yield strength values

text continued on page 60



LOAD-STRAIN DIAGRAM for composite of 18.5% molybdenum and 81.5% tin typifies most metal-metal combinations. Using analogy of coiled springs embedded in cold tar, various portions of load and recovery loop are as follows: (1) Elastic action, composite obeys Hooke's Law; (2) Plastic deformation, slope depends on loading rate; (3) Strengthening after yielding indicates skeleton is stiffening—some "coils" are compressed to their solid height; (4) Load exceeds yield of stiffened skeleton, thus deformation continues; (5) Composite creeps as change-over to unloading cycle occurs; (6) Skeleton recovers very slowly, resisted by plastically set impregnant and decreasing load; (7) Impregnant gives way to swiftly recovering skeleton, but recovery remains slower than unloading rate; (8) Embedded "coils" overcome restraint of viscous impregnant and compressive load at a rate that matches unloading rate; (9) Similar to (7); (10) Load is completely removed, material continues to recover hours later.



come from standard ASTM compression tests. Some compression testing has been done beyond the elastic limits of these materials to investigate their compression-recovery behavior. A typical load-strain cycle for a Mo-Sn composite is shown (top, p 59) with a brief explanation of each portion in terms of an analogous material—a mass of coiled springs imbedded in a volume of cold tar. Though this analogy is inexact, it gives a rough idea of metal-composite behavior. Tests of this nature, both at high and low temperatures, are currently underway to refine our understanding of these materials. Room-temperature recovery data for five of the composites listed in Table I are given, for several values of % deformation in Table III.

It is difficult to predict the behavior of any material to be used as a seal from compression-recovery tests, since pressure of the fluid being sealed exerts an influence. This is particularly true of hybrid materials like metal composites. Accordingly, a simple 6-bolt flange setup was devised to compare the resilience of the composites as gasket materials for sealing high-pressure air at both room and higher temperatures. In such a joint, the materials showing low bolt torque over a wide range of sealing pressures are the most suitable as static seals. Sealing characteristics for the six composite materials (curves, bottom p 59) show wide variation in sealing ability. Last column of Table I shows max temperature at which each material will maintain 5000 psi, after several pressure cycles, without significant loss of bolt torque.

As these data show, three combinations are suitable for static seals in the area of 1000 F. Two of these, Mo-Ag and Stainless-Mg, have impregnant melting points above the operating temperature. The other, No. 6, uses a truly inorganic polymer impregnant whose raw materials are introduced into the skeleton by melting. Called "inorganic rubber," this impregnant is reported to retain its properties —after formulation—up to about 1080 F. Even though this composite has lowest bolt-torque requirements, the two metal-metal composites are preferred until more is learned about high-temperature behavior of the inorganic polymers. The Stainless-Mg composite leaked upon repressurizing after cool-down, so the Mo-Ag system is the better choice where temperature and pressure cycle in operation.

Compatibility of Materials

The composite must not only provide the required mechanical behavior for static sealing; its skeleton and impregnant must be compatible metallurgically. Factors determining compatibility at high temperatures are discussed below. Table IV shows how these factors affect several logical combinations.

Phase changes. Properties of static-seal composites should not vary appreciably between room temperature and 1000 F. Thus the skeleton-impregnant system should not form intermetallics or undergo transformations since these phase changes are accompanied by sharp variations in properties in this temperature range.

Wettability. Porosity in the finished composite depends on how well the impregnant wets the fibers. An impregnant with good wetting characteristics (indium, for example) will fill complex crevices in the skeleton, keeping porosity to a minimum.

Melting point. If melting point of the impregnant is too near operating temperature, strength may drop sharply, recrystallization may occur, or the skeleton may start dissolving into the impregnant. If the impregnant will be molten at seal temperature, surface tension and viscosity will control whether the impregnant stays in the skeleton.

Alloying. Skeleton and impregnant should be selected for minimum mutual solubility at elevated temperatures. Excessive solubility rates will change composite resilience and other properties. High-elastic-modulus materials give highest resilience, but impregnants must be selected that will not alloy with them.

Fabricating Composite Materials

When a suitable skeleton-impregnant combination has been chosen, the composite is fabricated in the simplified, procedure outlined below. The 7 steps omit many innovations developed for specific combinations.

1. Fiber cutting. As-received wire or wool is chopped to nominal size in a hammer mill, or cut in shears for exact length control.

2. Degreasing. Lubricants left on the fibers from drawing process are removed with a trichloroethylene wash to improve feltability and promote subsequent bonding or wetting when the felt is impregnated.

3. Air felting. Clean, chopped fibers are shaken from a screen into a mold, usually simple in shape. Screen size as well as frequency and amplitude of vibration are controlled to achieve random fiber orientation and uniform dispersion. For more complex shapes, a water-and-fiber slurry

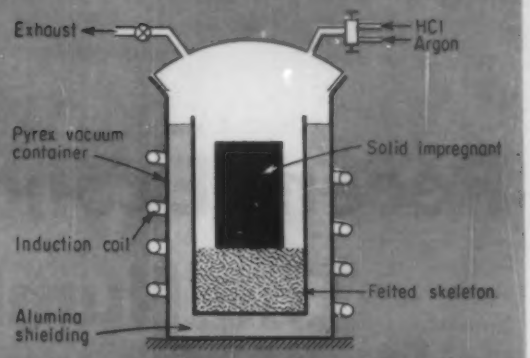
Table IV—Compatability of Skeleton and Impregnant

IMPREGNANT	SKELETON		REMARKS
	Iron	Molybdenum	
Aluminum	Dissolves skeleton, Forms intermetallics	Acceptable	
Barium	Acceptable	Acceptable	
Cadmium	Acceptable	No information	Cd forms toxic vapors
Copper	Acceptable	Acceptable	Cu work-hardens, has high yield strength
Indium	No information	No information	
Lead	Acceptable	Dissolves skeleton	Pb forms toxic vapors; oxidizes
Magnesium	Acceptable	Acceptable	Mg is brittle, has high yield strength
Silver	Acceptable	Acceptable	
Tin	Acceptable	Acceptable	

THE IMPREGNATING METHOD

At right is a schematic illustration of an impregnating chamber suitable for impregnants discussed in this article. All features are not needed for all impregnants, as noted in th procedural notes below.

IMPREGNANT	PROCEDURE
Tin	Place both skeleton and impregnant in crucible, close tightly, purge air with argon, purge argon with HCl gas (to improve wettability), heat to 750 F, allow sufficient boiling to clear molten tin of $SnCl_2$, pressurize with argon for instant impregnation. Alumina shielding not needed.
Indium	Same as for tin, but HCl flush unnecessary because indium wets well. Shielding not needed because, like tin, melting point is low.
Silver	Crucible needs alumina shielding because of silver's high melting point. Procedure same for tin, except temperature is raised to 2000 F and HCl flush is not needed.
Magnesium	Same as for tin, except temperature is 1500 F; and HCl flush unnecessary since Mg is self-fluxing. Some argon may be trapped in magnesium causing slight leakage when composite is used as high-pressure sealant.
Inorganic Polymer	Prepare crystals of the trimer $(PNCl_2)_3$ and tetramer $(PNCl_2)_4$, place skeleton in capped pipe nipple, spread crystals on skeleton and heat until they melt at about 250 F and sink into matrix, close nipple and heat assembly overnight at about 575 F to produce the rubbery polymer. This impregnant tends to hydrolyze, so exposed surfaces of seals must be treated to replace unstable chlorine atoms with stable groups.



can be deposited over a perforated mold on which a vacuum is drawn to remove the water. A drying step is then required.

4. Pressing. Density of felted bodies is easily increased by pressing while the air-deposited fibers are still in the mold. Control of density is necessary to gain precise control over proportions of skeleton and impregnant.

5. Sintering or brazing. Bonding the fibers at points of contact can increase composite strength as much as four times. Sintering raises fiber temperatures to the point where the fibers fuse at contact points; prolonged sintering produces higher bond strength, but may shrink linear dimensions as much as 18%. Brazing permits contact point bonding of metal fibers far below their sintering temperature. Here, fibers are co-felted with powdered brazing alloy in liquid suspension—usually glycerine. When heated, the alloy forms a normal brazed joint between fibers. Not all composites use bonded skeletons.

6. Impregnation. Properties and compatibility of the constituents control the precise technique chosen (see "Impregnating Method"). In brief, the skeleton is heated in an evacuated chamber; impregnant can be present during testing or introduced, molten, later. Replacing vacuum by inert gas pressure closes the remaining voids in the structure. For powdered impregnants, vibration gives best dispersion throughout the skeleton.

7. Shaping. Finished parts can then be shaped by conventional cutting processes. Most impregnants are soft and tend to smear, so cooling the stock before cutting is recommended. Pressure forming-processes like coining and rolling will work, too, and can also be applied to the fiber skeleton before impregnation. Machining is more difficult, mainly because density is low and bonds weak. But the felt can be temporarily impregnated with a water-soluble salt that will reinforce the skeleton during cutting. A suitable salt mixture of 44.5% potassium nitrate and 55.5% sodium nitrite (by weight) melts at 300 F, impregnates well at 380 F., and can be flushed out with water.

EDITOR'S NOTE: The above article is based on research supported by the US Air Force and monitored by the Materials Laboratory, Wright Air Development Ctr, Wright-Patterson Air Force Base.

Other recent articles on the behavior of fiber-based materials at elevated temperatures include:

High-temperature Reinforced Plastics, Nov 23 '59, p 58—With plasma, jets, oxyacetylene torches and rocket engines hurling their btu's at thousands of specimens, our body of data on fiber-reinforced plastics is growing. An expert explains these data and describes newly emerging theories of thermal protection.

How Gaskets Behave, May 25 '59, p 40—Sparked by more aluminum in car engines, gasket-design practices are being overhauled to fit high-temperature loosening.

What's New About the New Papers?, Feb 16 '59, p 50—New treatments add moisture resistance, stretchability, and heat and flame resistance: new fibers add strength and dimensional stability.

Glass and Ceramic Fibers—They Beat the Heat, July 7 '58, p 70—Modern technology is turning sand and clay into an increasing variety of thread-like materials with rugged properties. Article gives data on the three most important types.

Four Types of Synthetic Fiber Felt, July '57, p 178—They are shown to have higher strength, better corrosion- and heat-resistance than wool felts.

Recent Economic Growth — The Numbers Game

If it truly portrayed recent rates of economic growth in the United States, the report on employment, growth and price levels recently issued by the staff of the Joint (Congressional) Economic Committee would point up scarcely less than a national disaster. Among other things, it would document impressively Premier Khrushchev's crack that "the capitalist steed the United States is riding . . . is worn out."

One of the major findings of the Joint Committee's staff (in the Eckstein Report, named for its staff director Otto Eckstein) is that between 1953 and 1959 the average rate of growth of physical output in the United States was only 2.4 per cent per year. This is scarcely more than half the average annual rate of growth of 4.6 per cent the staff found to have prevailed between 1947 and 1953.

Happily, however, the report does not reflect the basic economic realities. Its finding on relative rates of economic growth for the two periods is a statistical *tour de force* which, by the selection of certain figures and certain dates, distorts the record of America's long-term economic growth.

Playing The Numbers Game

By the selection of appropriate starting and terminal periods it is possible to document almost any rate of economic growth that is desired. The table at the bottom of this page shows you how this can be done. It will also show you how the Eckstein staff worked out its shocking contrast in growth rates. The table is built like a schedule of airplane fares between different cities. The postwar years 1946 through 1959 are put down on two axes. One runs down the left hand column, the other runs across the top of the table. Put your finger on the point where the two axes intersect and you have the average rate of growth for the period covered.

ANNUAL AVERAGE GROWTH RATES OF THE U.S. ECONOMY, 1946-1959*

(Percent increases, starting year to terminal year, of GNP in 1954 dollars).

Starting Year \ Terminal Year	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959
1946	X	-0.1	-1.9	-1.2	3.0	3.9	3.8	3.9	3.2	3.7	3.6	3.4	2.9	3.2
1947	X	X	3.8	1.8	4.1	4.9	4.6	4.6	3.7	4.2	4.0	3.8	3.2	3.5
1948	X	X	X	-0.1	4.2	5.3	4.8	4.7	3.6	4.3	4.0	3.8	3.1	3.4
1949	X	X	X	X	8.7	8.1	6.5	6.0	4.4	5.0	4.6	4.2	3.5	3.8
1950	X	X	X	X	X	7.4	5.4	5.1	3.4	4.3	3.9	3.6	2.9	3.3
1951	X	X	X	X	X	X	3.4	3.9	2.0	3.5	3.2	3.0	2.2	2.8
1952	X	X	X	X	X	X	X	4.4	1.3	3.6	3.2	2.9	2.0	2.6
1953	X	X	X	X	X	X	X	X	-1.6	3.2	2.8	2.6	1.6	2.4
1954	X	X	X	X	X	X	X	X	X	8.1	5.1	4.0	2.4	3.2
1955	X	X	X	X	X	X	X	X	X	X	2.1	2.0	0.5	2.0
1956	X	X	X	X	X	X	X	X	X	X	X	1.8	-0.2	2.0
1957	X	X	X	X	X	X	X	X	X	X	X	X	-2.3	2.0
1958	X	X	X	X	X	X	X	X	X	X	X	X	X	7.0
1959														

*Compound rates of growth

Following this procedure, you can find growth rates ranging all the way from —2.3 per cent, between 1957 and 1958, to +8.7 per cent, between 1949 and 1950, along with almost any other rate you would choose for various years and sequences of several years over the postwar period.

For example, if you want to demonstrate that the postwar growth rate through 1953 was less than 4% per year, you take off from 1946, include a drop of 0.1 per cent between 1946 and 1947, and come up with a growth rate for the 1946-1953 period of 3.9 per cent. But if you want to show it was quite high, you take off a year later, from 1947 (which drops out that dismal —0.1 per cent for 1947) and come up with a fine growth rate of 4.6 per cent for the 1947-1953 years.

Statistical Hocus-Pocus

That's what the Eckstein staff did. It took off at one end from a year when there was just about no growth, went to the Korean War boom year of 1953 at the other end, and got that average growth rate of 4.6 per cent. Then it took off from the Korean War boom year of 1953 and ran to the year 1959, when business was recovering from a recession and suffered through a steel strike of 116 days, to come up with its 2.4 per cent growth rate for the second postwar period. As the table indicates, by taking off a year later (1954) the average growth rate would have become 3.2 per cent, and if the take off had been 1949 it would have been 3.8 per cent.

There are those who, in nontechnical terms, would characterize this as statistical hocus-pocus. There are also those who would see in it an element of political hocus-pocus, too. This is because the years 1947-53, when the Eckstein staff found there had been the healthy 4.6 per cent growth rate, were roughly years when we had a Democratic president, while the anemic growth rate of 2.4 per cent it calculated for the subsequent years was for years of a Republican presidency.

Actually it can be shown that the civilian part of our economy has had more rapid growth during the Republican administration than it had during the Democratic years. If military expenditures are subtracted from the national ouput, the resulting growth rate for 1953 to 1959 is slightly higher than for 1947 to 1953.

However, we do not question the *bona fides* of the Eckstein staff. **But we do assert that it has produced a statistical picture of the postwar growth of the American economy which is dangerously misleading both at home and abroad.**

Abroad, the report appears to give official documentation to the propaganda line that the Soviet economy is running rings around the U.S. economy in growth, and that it is Communism a country should choose if it really wants to develop rapidly. Building on a much smaller economic base than the U.S.A., the Soviet Union — as well as almost every less advanced nation in the world — is bound to show a larger percentage increase in output than the U.S.A. But the Eckstein staff calculation gives the Communists ammunition they don't deserve.

Are We Facing A Crisis?

The contrast drawn by the Joint Committee staff in postwar U.S. growth rates suggests that we are facing scarcely less than a crisis through paralysis of our economic growth which calls for drastic remedies. But this, as the full 1947 to 1959 growth record set forth in the table makes clear, is very definitely not the case. Our over-all postwar rate of growth, as measured by the gross national product in physical terms, has been 3.5 per cent per year, a rate nearly double the long-term growth rate of 2 per cent per year between 1909 and 1939. In the continuing fluctuations in the rate of growth which more or less inevitably characterize a relatively free economy, we have had some downs in recent years. **But our economy is now on the upbeat again. And at the end of this year, the U.S. economic growth rate for the postwar period can be expected to be 3.7 per cent per year.**

It is extremely important for the United States to continue to maintain this rate of economic growth or even to surpass it. Upon this effort depends our capacity to meet our defense requirements without dangerous strain, to provide an adequate margin for foreign aid, to improve our own productive facilities, and to continue to raise our own standard of living.

How not only to maintain but possibly improve upon our postwar pace of economic growth will be the subject of strenuous debate in the months ahead. However, the debate will have a much better chance of being constructive if the postwar growth record is seen in proper perspective. To this end one of the first things to do is to junk panic rousing statistical portrayals such as that in the Eckstein report.

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Donald C. McGraw

PRESIDENT

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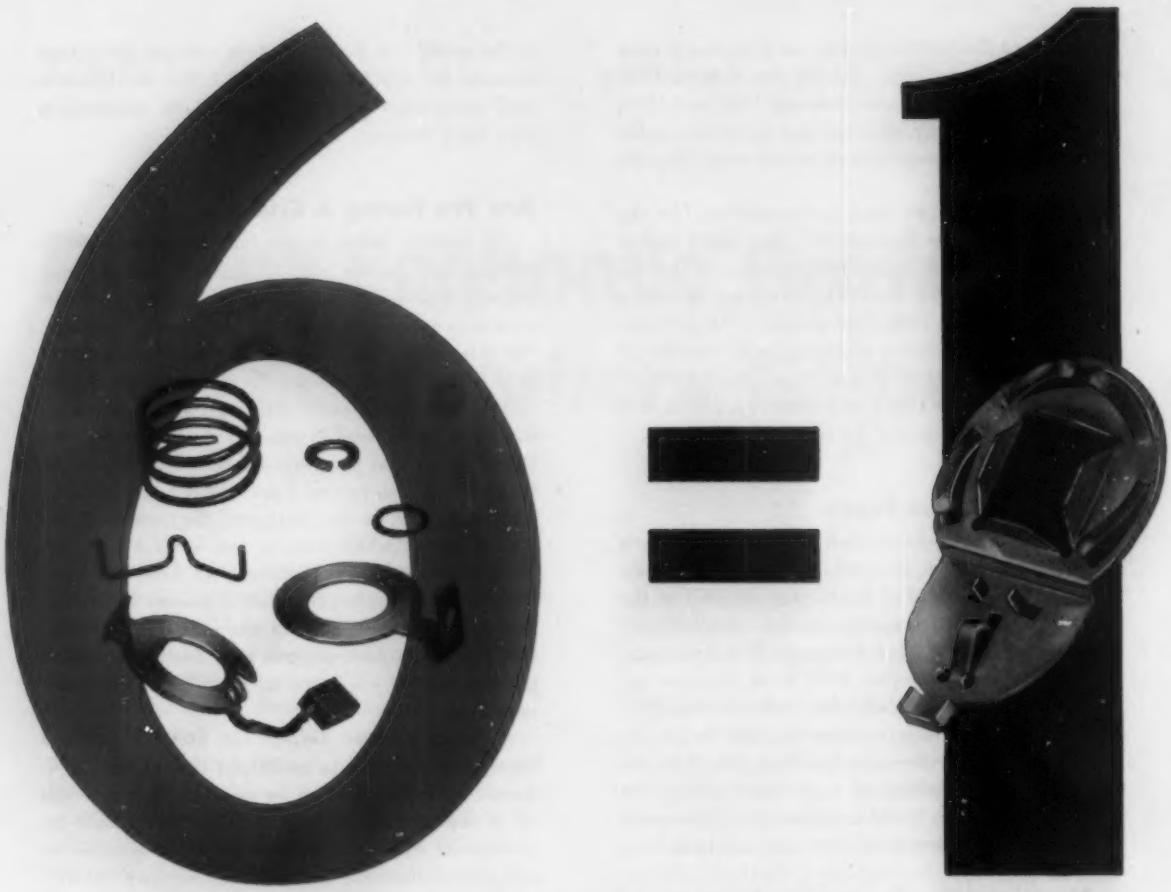

with re-design 'rithmetic

One flat spring now does the work previously required of the six parts shown—and greatly simplifies assembly, too. This single multi-purpose spring (a) holds a carbon brush in a rheostat, (b) applies pressure on the wire windings, (c) provides friction detent action, (d) acts as a retainer on the rotating shaft.

How did this come about? The maker of the rheostat undertook a complete redesign analysis, called in an A.S.C. Spring Engineer when it concerned the spring.

Early consultation with A.S.C. springmakers in new or redesign projects gives greater range to plans, safeguards against high production costs. Our booklet, "Designing Springs for Performance," may help you. Write for your copy.

8902

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
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BUILDING STRENGTH INTO BRACKETS

They must meet specific requirements—stability, light weight, and the like. Here's your guide.

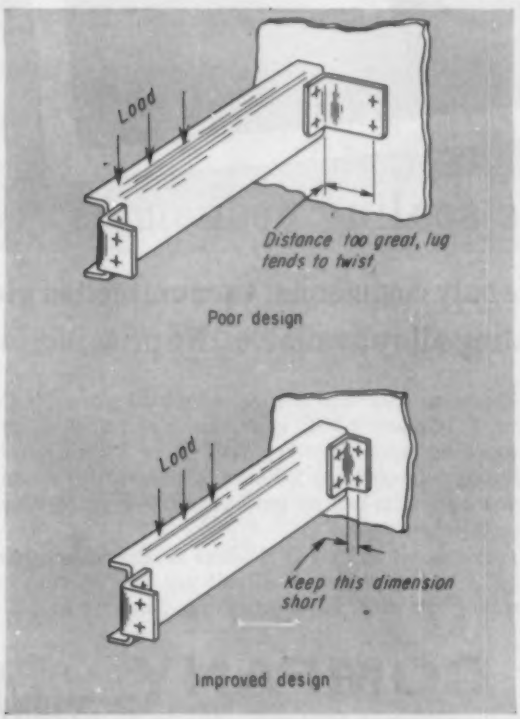
S WARREN KAYE

Raytheon Co, Bedford, Mass

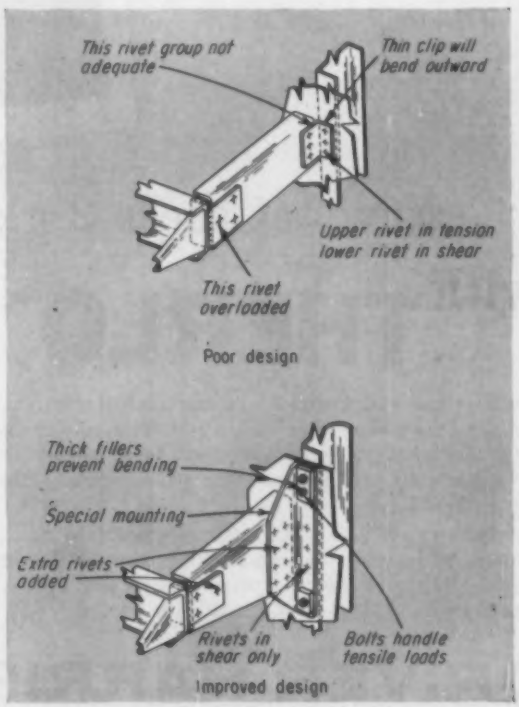
For stability, a good bracket must be able to carry load in three directions at right angles to each other—vertical, fore and aft, and sideways. Besides being able to withstand regular acceleration and operating loads, it must often be rugged enough to avoid damage from handling and accidental loads—for example, if it is stepped on, or used as a handhold, as in aircraft and missiles.

Space Age requirements also point up the frequent need to minimize weight of brackets. One way to do this is to place the equipment they support as near as possible to suitable attachment points on the basic structure. (Sometimes, in fact, by a minor rearrangement, such as shifting a stiffener or frame, the equipment can be attached directly to the structure, and the bracket eliminated.)

Other general rules for designing brackets: Avoid tension loads on riveted joints, do not combine rivets and bolts in the same local area; avoid using aluminum bolts in tension wherever possible; in a rivet pattern, avoid smaller rivets in the outer row; and don't overload first rivet or first row of rivets.



1 MOUNTING LUGS should be either kept short or have rivet locations that reduce twisting.



2 SPECIAL MOUNTING is best for cantilever bracket where large moments cause high tensile stress at mounting. If possible, design a one-piece bracket.

continued on page 67

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*T.M. Reg. U.S. Pat. Off.

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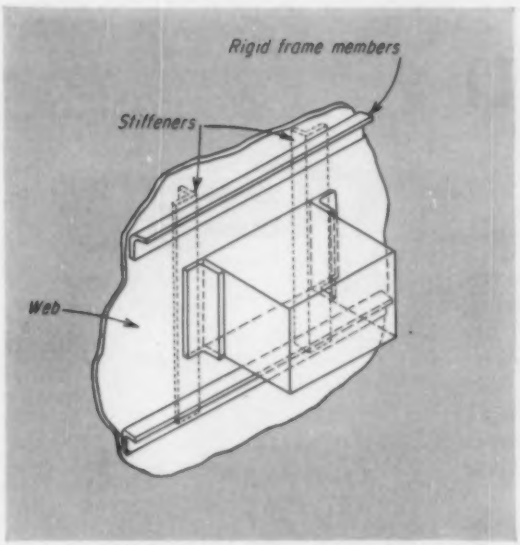
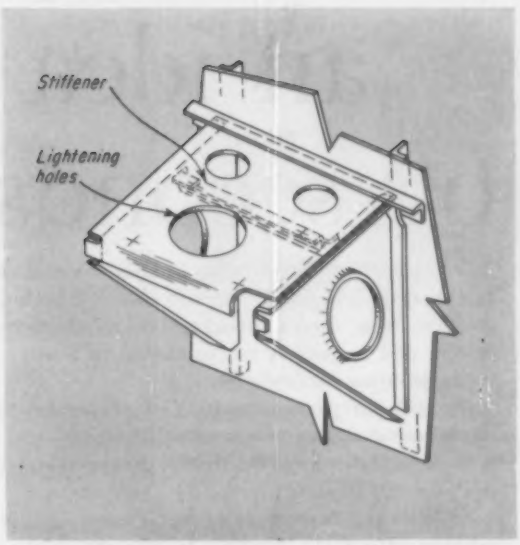
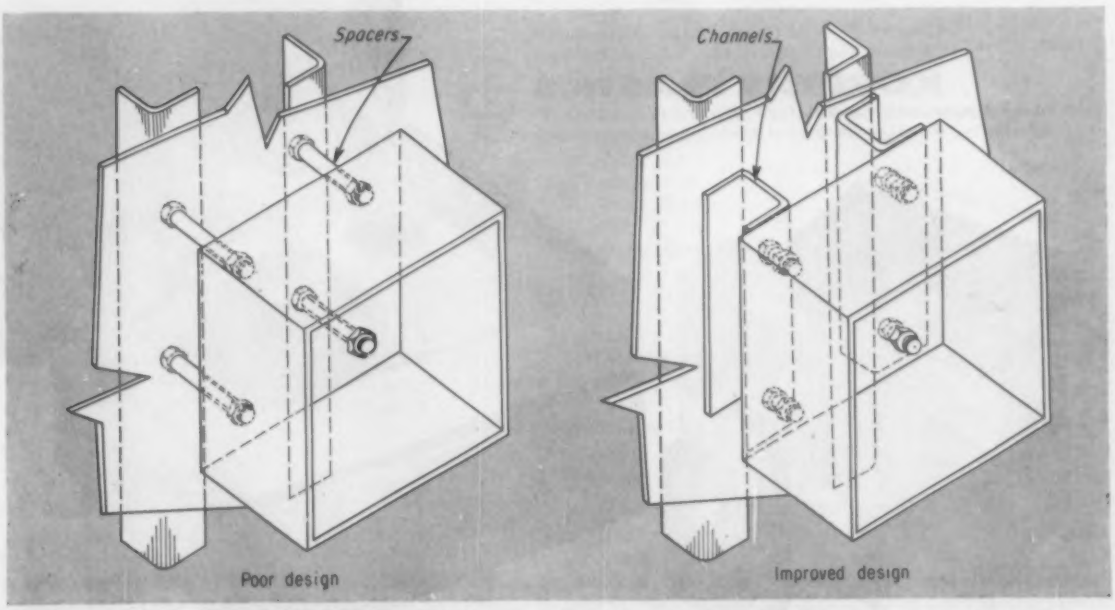
BRACKETS continued



3 STIFFENERS carry moment loads to rigid frame, prevent unsupported web from "oilcanning."



4 SHELF SHEET can be thinner and lighter if stiffeners are provided. Lightening holes are flanged where possible.



5 CHANNELS are best for spacing mounted equipment from attachment wall. Channel thickness must be sufficient to withstand bending from side loads. If necessary, extra stiffening should be provided.

use this page to develop an idea in 60 seconds

The Polaroid Land camera has had phenomenal sales success. It is expertly designed . . . the materials and workmanship are the best. Now, even the package is something special. The camera and accessories are cushioned in a seat of DYLITE® expandable polystyrene.

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(60 seconds are up. Did you get an idea? Write to Koppers Company, Inc., Plastics Division, Pittsburgh 19, Pennsylvania.)

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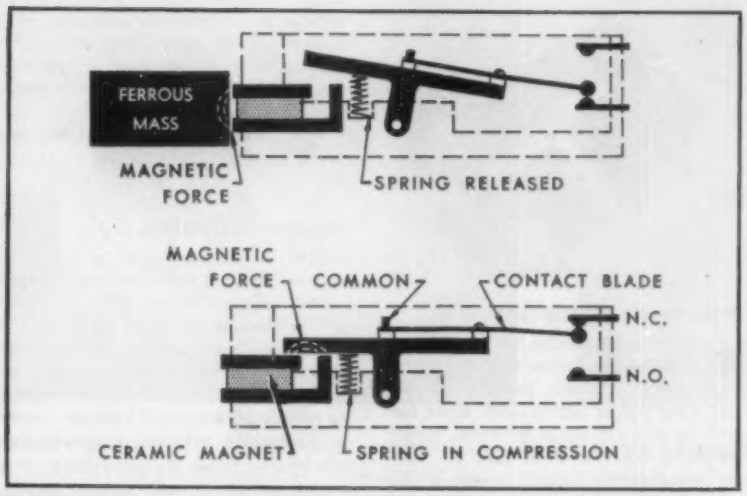

Change in path of magnetic flux operates proximity switch . . . that has snap-action similar to standard limit switch and repeatability said to be within 0.001 in. In sensing position (top illustration) magnetic flux from ceramic magnet flows through steel plates and ferrous mass being sensed, enabling contact blade to close circuit. In absence of ferrous mass, flux flows through pivoted iron beam, which holds it in place against force of compressed spring keeping circuit open. Inert gas atmosphere in sealed housing (phenolic body in brass shell) prevents oxidation and corrosion. Switch can be actuated by objects traveling either axially or tangentially. Actuating device can also be a selected contour or oriented magnet, to permit switching across larger gap. Contacts are rated 6 amp current at 110 v resistive and 3 amp at 220 v for nominal life. Measures 1⅞ x 2½ in. long. Prototypes for application evaluation are currently available; volume production is scheduled for Sept, '60. Price $17.50. **Tann Corp, 3750 E Outer Dr, Detroit 34.**

Circle 300 on Reader Service Card

Liquid Teflon lubricant . . .
is said to make wood, metal or ceramic surfaces slide smoothly, to prevent sticking and to guard against galling and wear. Coefficients of friction as low as 0.04 are reported to be possible. **R & R Co, PO Box 12, Park Forest, Ill.**

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Stock ballbearing pulleys . . .
for use in guiding motion of rope, wire rope or cable are available in six standard sizes. Pulleys handle cable sizes up to ¼ in. dia. OD ranges from ⅞ to 2 in.; bores from ⅜ to ¾ in. Bearing rings are made of case-hardened steel. Units are cadmium plated. Grooves are tapered and rounded to accommodate considerable latitude in cable or rope diameter. **Syracuse Bearing Co, 428 E Jefferson St, Syracuse, NY.**

Circle 302 on Reader Service Card

Ballbearing backstop and clutch employs balls . . .
as power-transmission members, rather than cams or springs. When free-wheeling, balls have spinning and rolling motion as contrasted with other clutches, which always depend on same surfaces to transmit load. This results in minimum free-wheeling drag. External dimensions of clutch are same as standard ballbearings and, therefore, permit incorporation into most types of power-transmission equipment. Standard shaft sizes range from ⅛ to 1½ in. dia; sizes up to 5 in. shaft dia are available. Normal torque for standard sizes ranges, from 2 to 1600 in.-lb. **Odin Corp, Castleton, Ind.**

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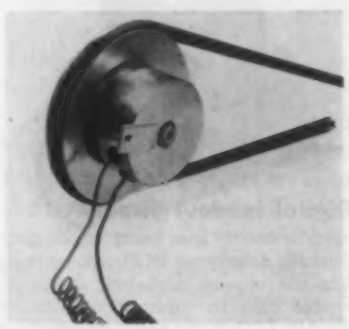

Miniature positive clutch . . .
for instrument applications has crown teeth that are magnetically engaged and spring-released. Teeth are pitched for easy engagement at low rpm and smooth acceleration. Develops 80 in.-oz torque.

continued on page 70

Can be wound for 28 v dc. Sheave can be mounted on driven hub, which also serves as armature. Clutch is 1¼ in. dia x ¾ in. long. **Stearns Electric Corp, 120 N Broadway, Milwaukee 2.**

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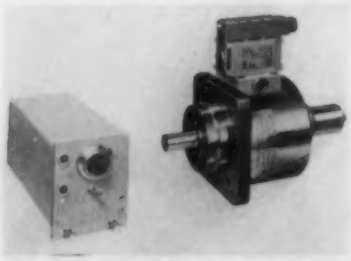

Variable-speed servodrives . . .

offer speed regulation, no load to full load, and long-term speed stability of about 0.1 rpm in zero-speed region. This characteristic and high available torque enable direct coupling of servodrive to such loads as machine-tool lead screws without intermediate gear reduction. No-load to full-load regulation at high end of speed range is approximately 0.2%. Actual speed is said to be within 1% of setting on speed-control dial. **Pegasus Laboratories Inc, 3690 11 Mile Rd, Berkley, Mich.**

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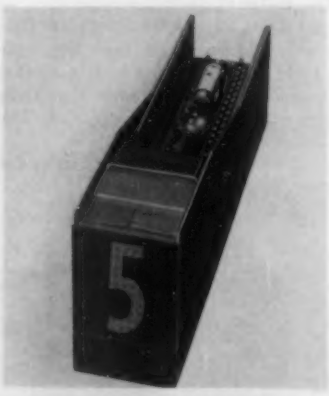

Digital readout display . . .

operates directly from binary input. Automatically decodes any BCD code up to six bits into numeric, alphabetic or special-symbol character presentation. Readout provides 16 digits or special characters and operates on light-interference principle. Each of 16 character plates in unit contains small holes that form digit or character. Light from single lamp in rear of unit passes through holes to form figure on front viewing screen. Continues to display character until commanded to accept and display new character. Power may be removed from unit without disturbing character on display. Requires 10 milliw of signal power. Measures 3¼ x 1 1/16 x 7 in. Weighs 2 lb 4 oz. Characters on viewing screen are ½ in. high. Priced at $40 each. Delivery, 30 days, for single units or in assemblies. **Industrial Electronic Engineers Inc, 5528 Vineland Ave, N Hollywood, Calif.**

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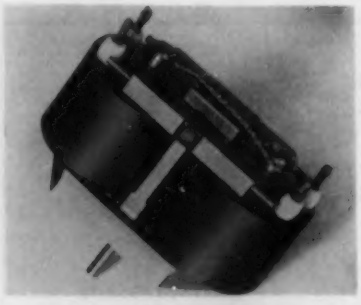


Polarized torque motor . . .

has operating capability up to 1250 F. Designed for continuous duty at elevated temperature. Provides proportional output force and/or motion with input current up to 0.010 in. linear stroke; torque output of 0.017 in.-lb at 1200 F. Tests are reported to indicate operating life of 20 hr minimum under these conditions. Electromagnetic-torque motor is adaptable to hydraulic or pneumatic applications as output shaft is sealed from motor elements. **Bendix-Pacific Div, Bendix Aviation Corp, 11600 Sherman Way, N Hollywood, Calif.**

Circle 307 on Reader Service Card

Piezoelectric transducers . . .

employing a ferroelectirc element for ultrasonic nondestructive testing, are available in all standard sizes in ranges from 200 kc to 10 mc. Said to be compatible with all types of equipment without modification and to be available in any standard connector. Offered in all standard focal lengths. **Automation Industries Inc, 3613 Aviation Blvd, Manhattan Beach, Calif.**

Circle 308 on Reader Service Card

Mechanical differentials . . .

are said to be low-cost units, intended to sell for under 10¢ each. Zinc-alloy gears and housings are die-cast by automatic process that produces complex gears and pinions as one-piece integral units with

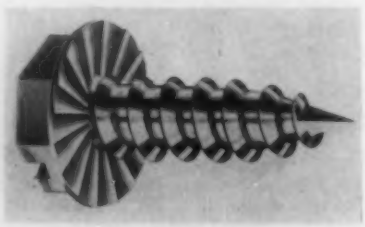
intricate external details. Differentials are suitable for adding and subtracting shaft movements, reversing shaft rotation, as variable speed changers or as clutch or brake. **Gries Reproducer Corp, 400 Beechwood Ave, New Rochelle, NY.**

Circle 309 on Reader Service Card

Tandem cylinders . . .

consist of two cylinders in line with common head at center and two separate pistons mounted on one solid rod. Available in bore sizes of 1½, 2, 2½, 3 and 4 in. and in lengths up to 80 in. Rods are stainless steel and steel or brass tubes are treated for corrosion. Units are intended to provide advantages of hydraulic control to air-operated cylinder. Hydraulic fluid can be used either in front cylinder or in center section of unit without makeup chamber. Full speed control is obtained by piping flow-control valves in series with two ports used for hydraulic section. By using pressure in both sections, usable force available is said to be twice as great as force obtainable from standard cylinder of same bore size. **Allenair Corp, 255 E 2nd St, Mineola, NY.**

Circle 310 on Reader Service Card



Hole-drilling tapping screw . . .

for use with light-gage metal, not only drills its own hole and forms its own thread, but has integral washer with serrated face that acts as built-in brake to minimize stripping and spinning. Designed for use with ¼-in. power screwdriver with adjustable clutch. Magnetic

continued on page 76

CIRCLE 71 ON READER SERVICE CARD→

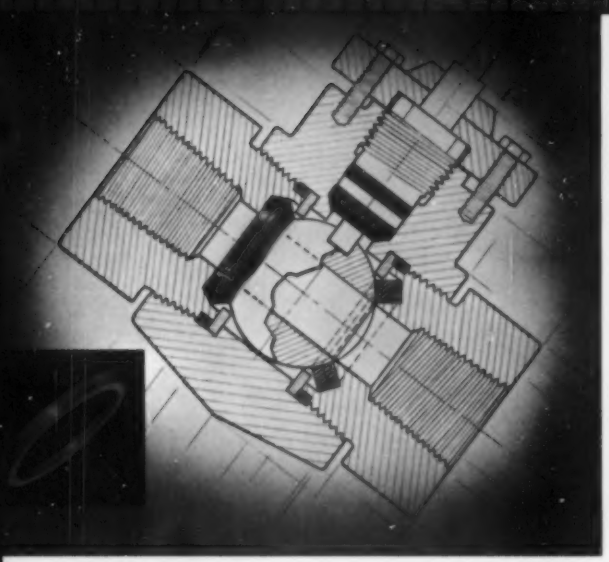
DU PONT

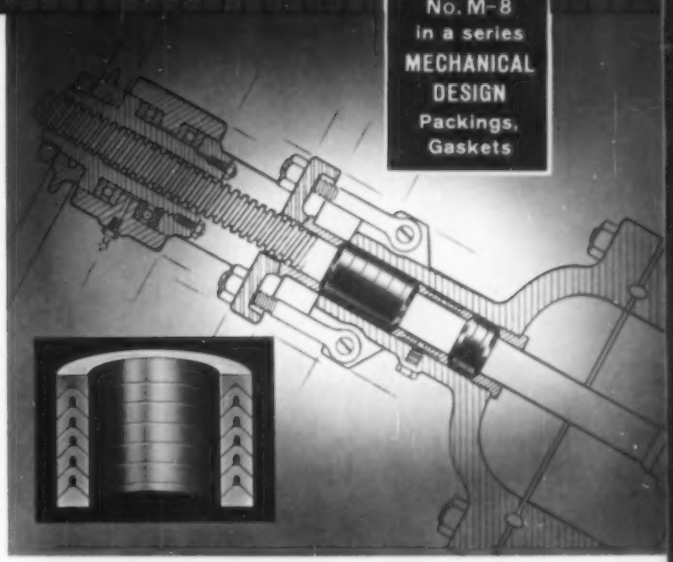
ENGINEERING FACTS ABOUT

TEFLON®

FLUOROCARBON RESINS

No. M-8
in a series
MECHANICAL
DESIGN
Packings,
Gaskets





Seats and stem gaskets of TFE resins assure tight-sealing, no-stick operation in these non-lubricated ball valves used in high pressure butane-propane service. User reports that these valves have been in operation for three and one-half years with no leakage or valve failure.

V-ring packings of TFE resins in valves for paper mill service eliminate the frequent changes of packing and periodic adjustments formerly required. In addition, losses of corrosive liquor are eliminated and wear on valve stems is sharply reduced.

Maintenance and replacement costs go down...productive capacity goes up...with packings and gaskets of TEFLON®

The two examples above typify the cost-cutting advantages of Du Pont TEFLON TFE resins as packing and gasket materials. In all applications, the use of TFE resins provides long service life . . . with the resultant savings in maintenance and replacement costs, plus increased productive capacity due to less downtime. In addition, a TFE resin can be used as an all-purpose packing and gasket material because it is resistant to virtually all chemicals and solvents over a temperature range from -450°F. to 500°F. This simplifies standardization. TFE resins are not affected by materials being processed and vice versa. The low friction characteristics of TFE resins often permit their use without lubrication, minimize torque requirements and reduce wear on pistons and shafts.

These are generalizations that have been put to the hard test of dollars-and-cents cost accounting in many hundreds of specific applications. In many instances, TFE resins have been found to be the only material that would give satisfactory performance. Also, when service demands are not exceptionally rugged, the increased reliability and longer life made possible by TFE resins have led to their specification in an increasing number of packing and gasket applications.

It will pay you to evaluate the use of TFE resins in your designs and equipment. To determine which of the many products made from TFE resins may be best suited for your packing or gasket application, consult the handy table on the next page.

OVER

TEFLON is Du Pont's registered trademark for its fluorocarbon resins, including the TFE (tetrafluoroethylene) resins discussed herein.

Guide to products made from TFE resins used in packing and gasket applications

APPLICATION	SOLID GASKETS	FILLED COMPOSITIONS	ENVELOPES	IMPREGNATED ASBESTOS CLOTH	SPIRAL WOUND	IMPREGNATED TFE RESIN FELTS	IMPREGNATED FIBER FELTS AND CLOTHS	V-RINGS	CUP AND CONE	IMPREGNATED ASBESTOS BRAIDED PACKINGS	SHREDDED PACKING	BRAIDED FILAMENT	UNMODIFIED RESIN	LAMINATED WITH GLASS CLOTH
METALLIC FLANGES	A	B	D	A	A	A	C							
NONMETALLIC FLANGES			D	A		A	C							
GLASS LINED FLANGES			D	A		A	C							
GLASS FLANGES			D	A		A	C							
RECIPROCATING RODS								E		G	F	K		
ROTARY SHAFTS										H	J	K		
VALVE STEMS								E	E	G	F	K		
PACKED EXPANSION JOINTS								E	E	G	F	K		
PISTON RINGS		A												A
MECHANICAL SEAL PACKING								E	E					
VALVE SEATS OR DISCS		B											C	B
DIAPHRAGMS		B											C	B
MECHANICAL SEAL FACES		A												
O-RINGS													A	

A—Usable to 550°F.

B—Generally used in the 400° to 500°F range.

C—Generally usable up to 400°F.

D—Usable to 550°F depending on the type of filler.

E—Can be obtained as unmodified resin or filled composition.

F—Preferably used with spacer rings.

G—The braid over braid type is preferred.

H—Generally usable with surface speeds up to 1200 F.P.M. The square plaited braid is preferred.

J—Generally usable for surface speeds in excess of 1200 F.P.M. Should be used with spacer rings.

K—Adapted for severe corrosive service.

Maximum performance and economy is obtained when gaskets and packings are properly designed and chosen for the specific sealing operation you have in mind. Optimum operating limits and conditions for a variety of types and uses are indicated in the table above.

FOR MORE INFORMATION about the wide variety of forms in which TFE resins are available for sealing applications, consult your supplier. And for additional information about properties and characteristics of TFE resins, and the many ways they have led to improved, economical designs, write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept., Room T-36530, Nemours Building, Wilmington 98, Delaware.

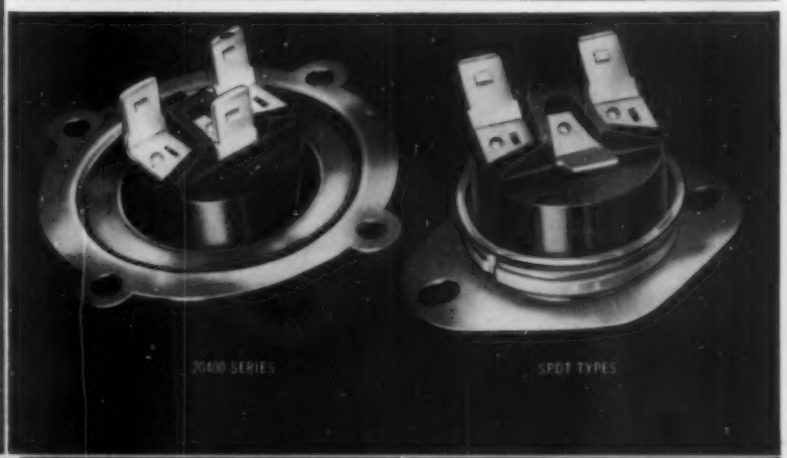
In Canada: Du Pont of Canada Limited, P. O. Box 660, Montreal, Quebec.

DU PONT REG. U.S. PAT. OFF.

TEFLON®

TFE-FLUOROCARBON RESINS

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*



KLIXON® THERMOSTATS
Provide Extra Value In Product Dependability

Original equipment manufacturers of refrigerators, air conditioners, freezers, dryers, heaters and other products expect reliable performance and *get it* with KLIXON disc type fixed temperature thermostats.

Illustrated above are but a few of the many constructions available. The 20400 and 20600 series are especially applicable as operating and limit controls. Relatively small in size, they have heavy duty electrical capacity . . . up to 25 amps., 120 and 240VAC resistive, U/L approved for 100,000 cycles.

The 20420 series sealed thermostats are used in air conditioning and refrigeration applications as operating and limit controls in the lower temperature ranges. Electrical rating . . . up to 16 amps., 120 and 240VAC.

KLIXON Thermostats provide accurate temperature control. Their operation is unaffected by altitude or cross ambients, shock or vibration.

Our Field Engineers will gladly help you make test applications. Write for technical data bulletins THSN-19, THSN-22 and THSN-23 today.

TEXAS INSTRUMENTS
INCORPORATED
METALS & CONTROLS DIVISION
3805 NORTH MAIN STREET • VERSAILLES, KENTUCKY
SPENCER PRODUCTS
Commercial Controls Department

CIRCLE 73 ON READER SERVICE CARD 73

Schlieren photograph showing heated air rising from Malleable chain link at 1200° F.

For Hot Parts... Use Malleable

Heat them up, cool them off—ten thousand times. Heat them up, keep them hot—indefinitely... you'll find you can count on Malleable iron castings for an exceptional combination of safety and economy.

New research demonstrates that the rugged room-temperature characteristics of Malleable castings remain virtually unchanged up to 800° F! More important—from 800° F. to 1,200° F., Malleable castings are unique in providing safe, dependable service **without** sudden drop in strength.

Let a nearby Malleable castings producer help you develop better, more economical parts for elevated temperature applications. Send drawings or an outline of your requirements to any of the progressive companies that display this symbol—

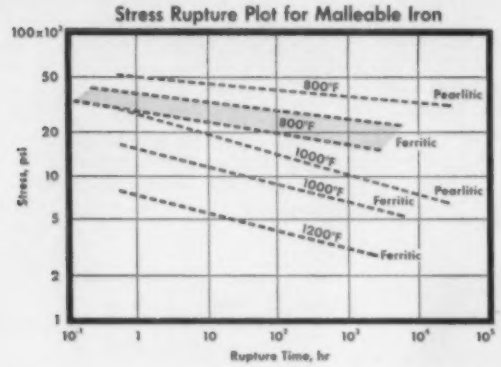
MEMBER
MALLEABLE
CASTINGS COUNCIL

For detailed information on "Use of Malleable Castings in Elevated Temperature Applications," contact any company listed on the opposite page, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

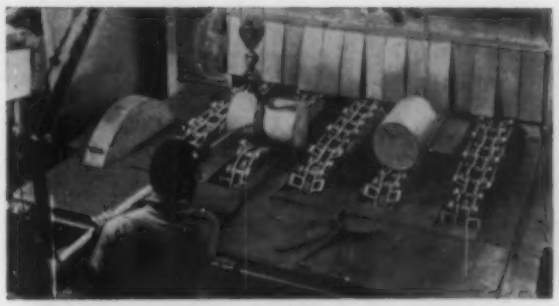
Get Dependable Strength At Elevated Temperatures With Tough, Economical Malleable Castings

Malleable iron castings give you excellent service under rugged conditions at temperatures up to 800F. Even at temperatures as high as 1200F, at reduced stress levels, Malleable castings offer uniformly predictable properties.

Compare these stress-rupture curves for Malleable iron with other ferrous metals. Malleable's are straight, gradually declining curves . . . not curves that break sharply and suddenly downward. With Malleable you can count on long life.



At temperatures from sub-zero to over 800F, Malleable delivers more strength per dollar than any other metal, ferrous or non-ferrous. In addition, your products will profit from Malleable's exceptional machining ease and uniformity, and the efficiency of the casting process.



Eight years of service at 900F without a failure! That's the history of these pearlitic Malleable conveyor chains carrying aluminum billets through a furnace. Similar Malleable chains have been subjected to temperatures as high as 1300F in sheet steel normalizing furnaces for years without failure.

Subjected to dynamic stresses at temperatures from 500 to 750F, these pearlitic Malleable truck and bus diesel engine pistons commonly provide more than 40,000 hours of service . . . over 1,000,000 miles!

Free Engineering Aid — To help you more exactly evaluate the possibilities of producing better products at lower cost with Malleable castings, send for *Data Unit 108—Elevated Temperature Characteristics of Malleable Iron Castings.* Your copy is available from any foundry listed below, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

For Quality and Economy... Use MALLEABLE

For Service In Your Area Contact...

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Link-Belt Company, Indianapolis 6
National Mall. & Steel Castings Co., Indianapolis 22

IOWA
Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI
Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division
Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

driver-socket fits any standard power driver. Only one size socket is needed, since all sizes from No. 6 to 10 have same size hex head. **Parker-Kalon, Div General American Transportation Corp, Clifton, NJ.**

Circle 311 on Reader Service Card

Epoxy-glass rolled tubing . . .

is available in $\frac{7}{8}$ to 12$\frac{3}{4}$ in. ID and $\frac{1}{4}$ to 13$\frac{1}{4}$ in. OD with min wall thickness of $\frac{3}{32}$ in. Tubing length is 38 in. Rolled tubing is made from epoxy-resin-impregnated glass cloth that is rolled and cured on mandrels. Tubing is reported to exhibit excellent physical properties, flame retardance, arc resistance and high flexural strength at 302 F. Suitable for use in heavy electrical equipment and military electronic equipment. **Continental-Diamond Fibre Corp, Newark, Del.**

Circle 312 on Reader Service Card

6PDT subminiature relay . . .

is designed with 0.2-in. grid spacing and 2-amp contacts. Hermetically sealed dc relay occupies less than 1 cu in. space and weighs 1.8 oz max. Relay withstands 50-g shock and 28 to 2000 cps vibration at constant 20-g and 5 to 28 cps at 0.5 in. double amplitude without malfunction. Standard coils include nominal voltages from 6 to 115 v dc with power rating of about 2.5 w. Also standard are coils for plate-circuit applications with pull-in as low as 7.5 milliamp with resistance of 11,570 ohm. Ambient temperature range is —85 to 257 F. Operate time is 8 millisec or less; release time is 5 millisec or less at nominal voltage at 77 F. **Allied Control Co Inc, 2 East End Ave, New York City.**

Circle 313 on Reader Service Card

Precision pressure switches . . .

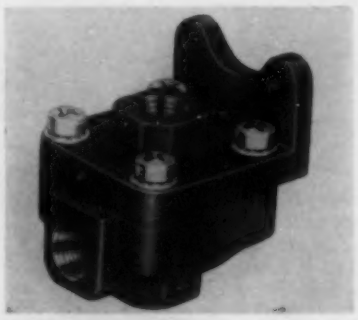
are externally adjustable. Used to convert fluid pressures into electrical on-off signals, nine models cover range from 2 to 3000 psi. Adjustable ranges of various units are from 2 to 12 psi, 6 to 25 psi, 20 to 75 psi, 50 to 125 psi, 75 to 250 psi, 100 to 500 psi, 250 to 1000 psi, 500 to 2000 psi and 750 to 3000 psi. Changes in actuation points are made by removal of plug and adjustment of splined screw. Operate in ambient temperatures from —65 to 275 F with accuracy said to be within 2% below 165 F; within 5% above 165 F. Designed for use with air, gas, oil and fuel. Withstand vibration to 2000 cps; shock to 100 g. Contact ratings are 2$\frac{1}{2}$ amp inductive or 5 amp resistive at 30 v dc or 5 amp at 125 or 250 v ac. Weigh 10 oz. Measure 1$\frac{3}{4}$ in. dia x 5$\frac{1}{2}$ in. long. **Consolidated Controls Corp, Bethel, Conn.**

Circle 314 on Reader Service Card

Self-contained heater . . .

burns gasoline, kerosene, diesel or any other liquid fuel and produces 6000 btu/hr. Measures 16$\frac{1}{4}$ x 3$\frac{1}{2}$ x 2$\frac{3}{4}$ in. Weighs 5 lb. Incorporates self-cleaning needle valve that permits wide range of turndown. Can be operated continuously. Automatic damper provides correct amount of combustion air for every setting. Fuel consumption is 1/20 gph at 6000 btu/hr, or 1/12 gph at 10,000 btu/hr (possible with modification). Hot air exits from top. **Janitrol Aircraft Div, Midland-Ross Corp, 4200 Surface Rd, Columbus 4, Ohio.**

Circle 315 on Reader Service Card



Air-shuttle valve . . .

selects and directs flow of air from one or the other of two controlling devices to a common outlet. Either controlling device may control operation. When one controlling device is actuated, inoperative controlling device is sealed from line. Pressure differential of just one psi will seal off low-pressure line and connect higher pressure line to outlet. Contains one moving part, a replaceable rubber diaphragm. Die-cast aluminum unit weighs 6 oz. Available with $\frac{1}{8}$ or $\frac{1}{4}$ in. NPT ports. Suitable for max air pressure of 200 psi; operating temperatures of —40 to 160 F. Intermittent temperature of 200 F is permissible. Price, $6. **Industrial Products Div., Westinghouse Air Brake Co, Wilmerding, Penna.**

Circle 316 on Reader Service Card

Reed relays . . .

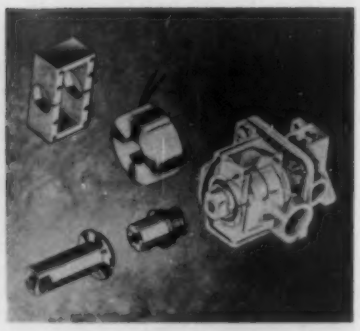
are based on design incorporating short pole piece with longer moving reed, which is said to permit higher operating speeds with conventional reed switches. Hermetically sealed, glass-encapsulated magnetic-reed switch is surrounded by operating coil to provide SPST normally open relay action. Suited for low-level switching or for low-power switching of loads up to 15 w and 250 v. Max operating current is 1 amp. Load life at $\frac{1}{4}$ of max rating is said to be about 200 million operations. Min operating power is approximately 100 milliw. Switch is 3$\frac{1}{4}$ in. long and 0.215 in. dia. Single contact relay with coil is about $\frac{7}{8}$ in. dia. **Struthers-Dunn Inc, Pitman, NJ.**

Circle 317 on Reader Service Card

Indicating temperature control

is said to be accurate over range of 100 to 1000 F. Models feature three sensing-bulb styles. Reference between setting and controlling temperatures is provided by single scale with two pointers. Mercury-filled thermal system is bellows-operated with nickel-plated brass bellows housing and 3 to 8 ft of stainless steel capillary. Several switch actions, including normally open or closed and double-throw, are available. Ratings are 15 or 20 amp, 115/230 v ac. Snap-action switches are SP and suitable for operation up to 180 F. **United Electric Controls Co, 85 School St, Watertown 72, Mass.**

Circle 318 on Reader Service Card



Three-way control valve . . .

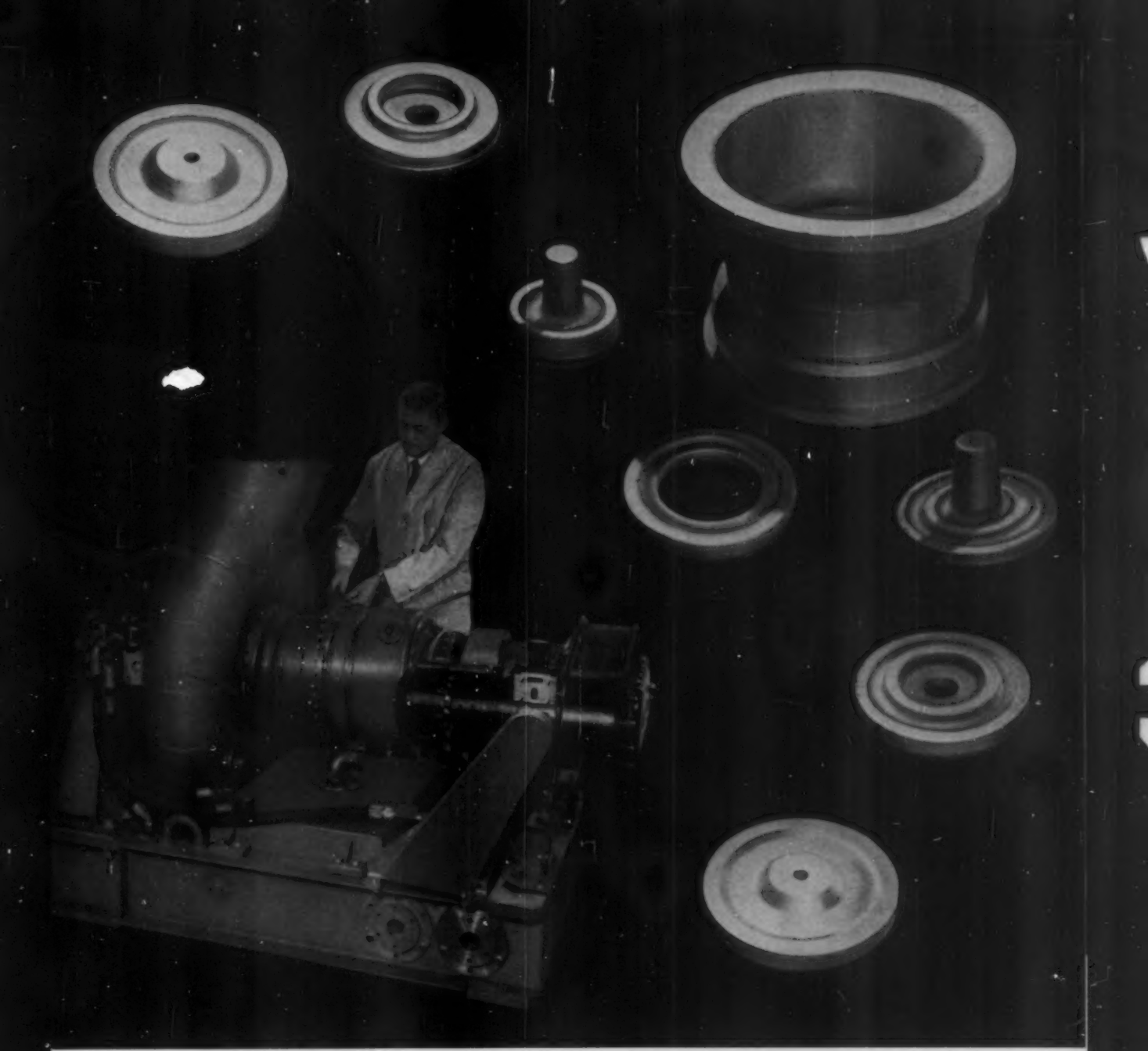
regulates direction of air, oil and inert gases and can be used on vacuum down to 5 microns. Available in $\frac{1}{8}$, $\frac{1}{4}$ and $\frac{3}{8}$ in. orifice sizes. Valves mount in any position directly to line and operate on pressure differentials to 250 psi, depending on orifice size. Built to UL standards. Bodies are die-cast zinc and internal parts are stainless steel. List prices start at $18. **Skinner Electric Valve Div, Dept DCA-154, 105 Edgewood Ave, New Britain, Conn.**

Circle 319 on Reader Service Card

Asbestos-phenolic compound . . .

is said to have excellent molding properties and can be used on transfer and com-

continued on page 78



CAMERON FORGINGS IN THE SOLAR SATURN* ENGINE

Solar Aircraft Company's 1,100 H.P. Saturn Industrial Gas Turbine Engine weighs about 1,000 pounds—its unusually efficient performance is setting new standards in new applications for the up and coming gas turbines. Increased reliability and versatility in gas turbines required something new in forging performance. That's why Solar called on Cameron for all the rotating forgings in the Saturn.

Both pure jet and turbo jet forged components from Cameron had already hit a new high in forming and metallurgical refinement. Properties at elevated temperatures consistently exceeded specifications, often as much as 20%. The Cameron forged Saturn engine components attest once more to the high quality and favorable properties which have become a specialty with us. Cameron perfected processes have no exact counterpart in forging history. Ten years of steady success have supplied us with a wealth of case histories and technical refinement. If you design, specify, or purchase ferrous forgings for demanding service (exotic metals, extreme temperature, etc.), in conventional or unusual shapes, from a few pounds to 13,000 pounds in weight—just write, call or come by.

*A Registered Trademark of Solar Aircraft Company

Cameron
IRON WORKS, INC.
SPECIAL PRODUCTS DIVISION
P. O. Box 1212, Houston 1, Texas

CIRCLE 77 ON READER SERVICE CARD

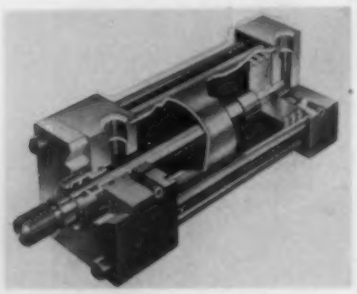
pression molds involving intricate details. Material has low bulk factor of 3 to 1, which permits use in automatic preforming equipment. Heat distortion temperature is over 500 F, molding shrinkage is less than 0.001 in. per in., impact strength is 2.5 ft-lb (notched bar) and flexural strength is 12,000 psi. Approved for applications under MIL-M-14F, Type MFI-20. **Rogers Corp, Rogers, Conn.**

Circle 320 on Reader Service Card

Heavy-duty transmissions . . .

convert any constant-speed input into infinitely adjustable output speed. One or more adjustable speeds can be preset and selected, depending on choice of integral control devices, in one or both directions up to 1650 rpm. Also, integral with these units is gearpump, cooling fan, fluid-reservoir case and overload-relief valves. For applications of 1 hp or less, units consume power only in proportion to work performed. Restricted-flow or directional-control valves are not used. Input speed is 1750 rpm. Starting torque is 62 in.-lb; normal torque is 45 in.-lb. Net weight is 90 lb. Measures 15 x 14 x 10¼ in. **Oilgear Co, 1570V W Pierce St, Milwaukee 4.**

Circle 321 on Reader Service Card



Hydraulic cylinder line . . .

for medium-high-pressure hydraulic service is for use with 1000-psi pumps. Available in bore sizes from 1 through 8 in., all designed to operate at full 1000 psi hydraulic pressure. They are of square-head and tie-rod design. Case-hardened and hard chromium plated piston rods are standard. **Hannifin Co, Dept 126 Des Plaines, Ill.**

Circle 322 on Reader Service Card

304 stainless with boron . . .

is said to offer high neutron absorption and excellent mechanical properties. Alloy contains up to 2% of boron-10 isotope. As boron content in steel is increased, tensile and yield strength are also said to increase, while ductility, impact strength and corrosion resistance decrease. Now, addition of 0.2% boron-10 to type 304 stainless steel produces essentially same nuclear properties as type 304 with 2% natural boron, but has improved mechanical properties. Available in hot-rolled bars, cold-drawn bars, strip and wire. **Carpenter Steel Co, Reading, Penna.**

Circle 323 on Reader Service Card

Dc timing motor . . .

is permanent-magnet type employing commutator and brushes of improved construction. Rotor cage is made of Inconel. Motor is reversible by changing polarity. Speed is directly proportional to voltage, within specified limitations. Constant voltage speeds from 1/15 to 60 rpm, with standard windings, can be supplied. Standard voltages are 6, 12 and 28 v. Life-lubricated motor has totally enclosed gear train. **Haydon Div, General Time Corp, 245 E Elm St, Torrington, Conn.**

Circle 324 on Reader Service Card

Teflon tubing . . .

in thin and standard-wall spaghetti, lightweight, industrial, and aircraft types and small diameter rod are produced with compounds to meet customer requirements. Wall thickness of tubing available has range from 0.005 in. to any wall desired. Special extruded shapes are also available. **Timely Technical Products Inc, S Jefferson Rd, Whippany, NJ.**

Circle 325 on Reader Service Card

UL-approved relay . . .

is magnetically operated. The 3PDT unit is rated for 5 amp at 115 v ac; DPDT unit is rated for 10 amp at 115 v ac inductive. Other contact arrangements of one to three poles, single or double throw, are available for ac or dc operation. **Davis Electric Co, Cape Girardeau, Mo.**

Circle 326 on Reader Service Card

Full-ported solenoid valves . . .

have direct-lift action. Designed for pressures from 0 to 1500 psi and for temperatures from —350 to 450 F. Available in bronze or stainless steel in ¼ to 1 in. pipe sizes. **Atkomatic Valve Co, 545 W Abbott St, Indianapolis.**

Circle 327 on Reader Service Card

Rotary circuit selector . . .

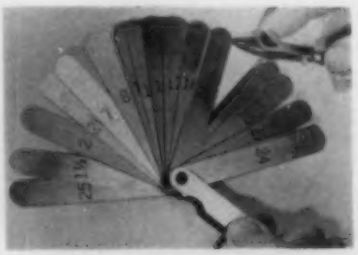
or stepping switch is powered by size 5 stepping motor (PE—Apr 25 '60, p 66). Self-stepping is provided by transistor-equipped pulser incorporated into switch package. Pulser is said to meet environmental requirements of MIL-E-5272. Standard stepping rate is 6 to 8 pulses per sec. Free-turning shaft allows manual setting of switch to any position, clockwise or counterclockwise. Switch can be ordered with 1 through 10 switch decks and in 8, 10, 12, 18, 20 and 24 positions. Applications include stepping, counting, adding, subtracting, programing and sequencing. **Ledex Inc, 123 Webster St, Dayton 2, Ohio.**

Circle 328 on Reader Service Card

Infrared detector control . . .

detects infrared radiation in visible spectrum and short wave-length range from radiating sources. Sensitivity permits detection at considerable distances, and is reported not to deteriorate with age. Sensing head detects radiation from objects with temperatures as low as 1000 F and from any higher temperatures. On electronic control chassis are mounted a control relay (plug-in unit is plastic-enclosed), an isolation transformer, cold-cathode tube that requires no warmup time, all necessary resistors and capacitors, and terminal strip. Sensitivity adjustment is provided on control panel to compensate for variations in intensity of radiation. **Euclid Electric & Mfg Co, Madison, Ohio.**

Circle 329 on Reader Service Card



Line-width adjuster . . .

is jack-knife arrangement of 25 flat steel feelers, ranging in thickness from 1½ to 25/1000 in. Inserted between pen blades during adjustment, any feeler will arrange for ink line of corresponding width. Said to match line with line, pen with compass, new work with old. Price $3. **Laramie Chemical Corp, PO Box 266, Ridgeway Sta, Stamford, Conn.**

Circle 330 on Reader Service Card

Drafting-symbol stamps . . .

in transparent vinyl and lucite reproduce thousands of technical symbols for fields of electronics, hydraulics, mechanical engineering and electricity. Any symbol or complex of symbols can be made to specification. Stamps are said to reproduce accurately and clearly. **John Griffin Co, 2117 Grand Ave, St Paul 5.**

Circle 331 on Reader Service Card

Nature's Tiny Flashlight. There's more to the surprisingly bright flashes of the firefly (*Lampridae*) than the body chemicals which it burns. In addition, a clear, curved section of the insect's skin acts as a magnifying lens and a layer of crystals as a reflector.

Miniature Angle Counter. Moving tape on this counter used in aircraft (approx. 3½" long) shows horizontal angular deviation from pre-set point. MPB bearings on key shafts help keep torque at approximately 0.1 ounce-inch at temperatures from −55°C to +125°C!

Man with Miracles. Scott Claytor is constantly helping industry and aviation to solve problems of friction and inertia with MPB bearings. Like all MPB Technical Representatives, he'll be glad to help *you* meet the challenge of miniaturization efficiently and economically.

Miracles in Miniaturization

ACTUAL SIZES OF THE MPB BEARINGS USED IN ANGLE COUNTER SHOWN ABOVE

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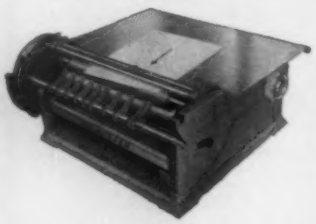

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DESIGN LITERATURE

How to Take a Chance

HUFF and GEIS. W W Norton & Co Inc, 55 5th Ave, NYC. 6 x 8, 173 pp. $2.95.

Like their earlier and highly successful collaboration. *How to Lie with Statistics*, Huff and Geis' *How to Take a Chance* offers a light-hearted briefing on a serious subject.

Probability theory is the underpinning of the modern world. Current research in both physical and social sciences cannot be understood without it. Today's politics, tomorrow's weather, and next week's satellite all depend upon it.

By ignoring, or failing to grasp, the laws of chance, we hurt ourselves in many ways. We buy insurance we don't need and fail to insure the risks we should. We make damaging decisions in business and in driving a car. We invest in systems at roulette, play unnecessarily bad bridge, and draw to inside straights. This book gives a clear concept of the basic laws of chance—although it makes no attempt to provide a mathematical basis.

Incidentally, the author points out the danger in unconsciously assuming that because there is only 1 chance in 1000 for an event to occur, that the event will not occur at all. For example, on August 18, 1913, at the Casino in Monte Carlo, black came up a record twenty-six times in succession. What actually happened was a near-panicky rush to bet on red, beginning about the time black had come up a phenomenal fifteen times. In the application of the maturity doctrine, players doubled and tripled their stakes, this doctrine leading them to believe after black came up the twentieth time that there was not a chance in a million of another repeat. In the end the unusual run enriched the Casino by many millions of francs.

Tensile Properties of Metal After Rapid Heating

J ROBERT KATTUS, Wright Air Development Center. 151895 (WADC Technical Report 58-440). Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 161 pp. $3.

The strength of all metals decreases with rising temperature. If the material is metallurgically stable, holding at the elevated temperature prior to testing has no effect on strength. Increasing the strain or loading rate makes the metal fail at a higher strength.

This report summarizes results of exhaustive tests on 14 standard structural materials. They include: alloys of aluminum, magnesium, titanium, stainless and the superalloys in various heat treatments.

Test specimens were quickly heated at various elevated temperatures and held from 10 sec to 30 minutes; then pulled at strain rates from 0.000,05 in. to 1.0 in./in./sec.

This report is a very good source for high-temp tensile data for short time applications.

Applications of Electronics

GROB and KIVER. McGraw-Hill Book Co Inc, 330 W 42nd St, New York 36. 6 x 9, 628 pp. $7.

This second volume of a two-volume package (first was Basic Electronics) explains in careful, practical language the design and operating principles for equipment in many specialized electronics and communications fields. Included are amplifier and rectifier circuits using electron tubes and transistors, oscillator circuits, microwave tubes, receivers and transmitters, industrial electronics, electronic navigational aids, test equipment, and military electronics.

Recent advances included are: explanation of transistor operation; schematic diagrams for transistor radios; explanation of line of sight, sky waves and scatter propagation; microwave oscillators; pulse generators. There are self-examination questions, with answers, at the end.

Other Books of Interest

Studies of the Effect of Dynamic Preloads on the Mechanical Properties of Steel

PB 151685. R C Smith. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 13 pp. 50¢.

Digest of Technical Papers—1960 International Solid-state-circuits Conference

Moore School of Electrical Engineering, Univ of Penna, 200 S 33rd St, Philadelphia. 8½ x 11, 96 pp. $5.

continued on page 82

OZALID NEWSLETTER

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CIRCLE 81 ON READER SERVICE CARD 81

Dimensions, Units and Numbers
Ford and Cullman. Bureau of Publications, Columbia Univ, NYC. 5 x 8¼, 47 pp. $1.

A Bibliography on Gas-lubricated Bearings—Revised
E B Sciulli. Office of Technical Services, Dept of Commerce, Washington 25, DC. 8½ x 11, 104 pp. $2.50.

Science in Industry
Carter, Williams. Oxford University Press, 417 Fifth Ave, NY 16. 5½ x 8¾, 186 pp. $3.40.

Proposals for the furthering of science within the framework of the British government.

Distortion in Tool Steels
J Parina. American Society for Metals, Metals Park, Novelty, Ohio. 173 pp. $10.

Discusses dimensional changes occurring during and after heat treatment.

Effect of Hardness & Other Mechanical Properties on Rolling-contact Fatigue Life of Four High-temperature Bearing Steels
Carter, Zaretsky, Anderson. National Aeronautics & Space Administration, Washington, DC. 8 x 10½, 51 pp. $1.50.

American Standard Requirements for Electrical Indicating Instruments
American Standards Assn, Inc, 70 E 45 St, NY 17. 8½ x 11, 49 pp. $2.50.

ABSTRACTS FROM THE LITERATURE

Design for Drawing

Data sheet (one page) provides details of design recommendations for drawing metal parts. Among factors discussed are corners, radii, forming contours, required draft, common drawing defects and characteristics.

"Design Characteristics in Drawing Metal Parts." Metal Progress, May '60, Metals Park, Novelty, Ohio.

Solenoid-valve Capacity

These methods of specifying solenoid-valve capacity are discussed: max pressure drop; min pressure required; coefficient of flow; equivalent orifice. In some cases, some relevant curves and equations are included.

"How to Specify Solenoid-valve Capacity." Design Engineering, May '60, 481 University Ave, Toronto 2, Canada.

Acetal Resins

Properties, methods of processing and applications of the group of plastic materials known by the trade name, "Delrin," are reviewed.

"Acetal Resins," G. F. C. Barrett, Du Pont Co Ltd. Plastics, April '60, Bowling Green Lane, London EC 1, England.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 85.

NICKEL-ALLOY HELICAL SPRINGS—Bulletin T-35, 48 pp. Information on manufacture of springs as well as properties, production and thermal treatments of nickel-alloy spring wires. Huntington Alloy Products Div, International Nickel Co Inc, 67 Wall St, New York 5.

Circle 340 on Reader Service Card

ELECTRONIC HARDWARE AND RESISTORS—Catalog 62, 96 pp. Covers stock wire-wound resistors and electronic hardware, with dimensions, specifications and prices. Sterling Precision Corp, Instrument Div, 17 Matinecock Ave, Port Washington, NY.

Circle 341 on Reader Service Card

THERMAL TIME-DELAY RELAYS—Catalog, about 12 pp. Data sheets present part numbers, time-delay ranges and voltage. Thermal Controls Inc, 43 River Rd, North Arlington, NJ.

Circle 342 on Reader Service Card

COAXIAL CONNECTORS—Bulletin, 12 pp. Contains descriptions of various units in TNC Series. Functional diagram illustrates types and flow of connectors by cable sizes. Also included is presentation on calibrated reliability with accompanying graphs. Kings Electronics Co Inc, 38 Marbledale Rd, Tuckahoe 7, NY.

Circle 343 on Reader Service Card

ENGINE SELECTION—Brochure, 28 pp. Emphasizes features of various designs. Discusses factors such as design, material, workmanship, cost of operation and reliability. Cut-away illustrations compare four- and two-cycle operation; multiple- and single-orifice injection valves; precombustion chamber and direct injection of fuels. Caterpillar Engine Div, Caterpillar Tractor Co, Peoria, Ill.

Circle 344 on Reader Service Card

POWDERED POLYETHYLENE—Booklet, 8 pp. Explains uses for finely divided or powdered polyethylene. Indicates sizes available. With photos and drawings. US Industrial Chemicals Co, 99 Park Ave, New York 16.

Circle 345 on Reader Service Card

ELECTRIC MOTORS—Condensed motor-data and price bulletin 150, 14 pp. Dimensions, specifications and prices of fhp and integral horsepower motors. Doerr Electric Corp, Cedarsburg, Wis.

Circle 346 on Reader Service Card

SILICONE MATERIALS—Handbook, 12 pp. Reference guide covers electrical and mechanical properties of silicone materials, describes typical applications, and contains performance and processing information. Dow Corning Corp, Midland, Mich.

Circle 347 on Reader Service Card

VARIABLE TRANSFORMERS—Bulletin 151, 8 pp. Describes high-current variable transformers for low-voltage applications. Ohmite Mfg Co, 3681 Howard St, Skokie, Ill.

Circle 348 on Reader Service Card

TRANSFER PAPERS AND FILMS—Bulletin 200, 6 pp. Presents descriptions and applications for diffusion transfer photocopy papers and films. Ampto Inc, Newton, NJ.

Circle 349 on Reader Service Card

PRECIOUS METALS FOR INDUSTRIAL USES—Bulletin GP-22, 6 pp. Outlines sizes, compositions and uses of solid and clad gold and silver strip, tubing, wire, brazing alloys and waveguide tubing. General Plate Products, Texas Instruments Inc, Metals & Controls Div, 34 Forest St, Attleboro, Mass.

Circle 350 on Reader Service Card

REACTIVE AND PRECIOUS METALS—Pamphlet, 4 pp. Discusses processing facilities for converting reactive and precious metals into wire, sheet and special shapes for use in nuclear and electronic fields. Metal properties and characteristics are listed. Consolidated Reactive Metals Inc, 115 Hoyt St, Mamaroneck, NY.

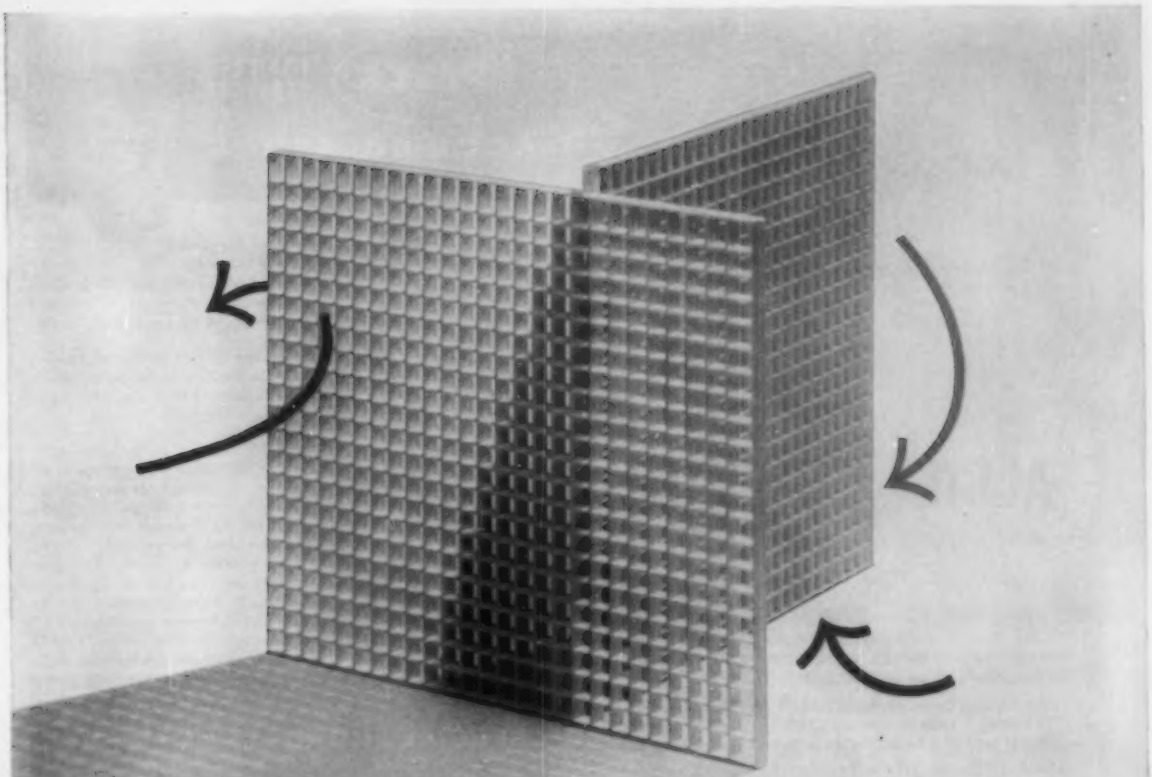
Circle 351 on Reader Service Card

SULFUR-COPPER ALLOY—Handbook C-17, 8 pp. Covers properties, performance and fabricability of alloys that offers machinability rating of 90. American Metal Climax Inc, Amco Div, Rockefeller Center, New York 20.

Circle 352 on Reader Service Card

PRESSURE INSTRUMENTS—Catalog S-60-1, 4 pp. Lists operating specifications, design requirements, dimensions, weight and accuracy of pressure-operated

continued on page 85



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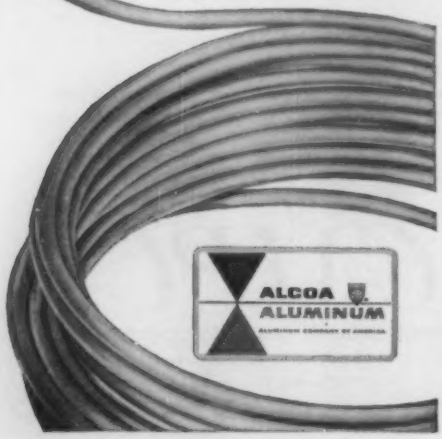

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PUSHBUTTON SWITCHES – Bulletin 7000, 4 pp. Describes single- and double-row assemblies of from four to 12 stations. With photos, dimensional drawings and specifications. Donald P Mossman Inc, Brewster, NY.

Circle 354 on Reader Service Card

DIGITAL READOUT SYSTEM – Brochure 22, 6 pp. Describes and gives specifications of dynamic digital system, which converts information normally presented in graphic form directly into automatic-printing digital form. Instron Engineering Corp, 2500 Washington St, Canton, Mass.

Circle 355 on Reader Service Card

HEATED GAGES AND VALVES – Data sheet 363, 4 pp. Gives information on heated gages and valves that have wide application where liquids must be kept at higher-than-ambient temperatures. Jerguson Gage & Valve Co, 80 Adams St, Burlington, Mass.

Circle 356 on Reader Service Card

SEQUENTIAL SWITCHING–Bulletin 20, 2 pp. Specifications of model-CS stepping relay. Includes dimensional drawing and typical circuit-wiring diagram. Artisan Electronics Corp, 171 Ridgedale Ave, Morristown, NJ.

Circle 357 on Reader Service Card

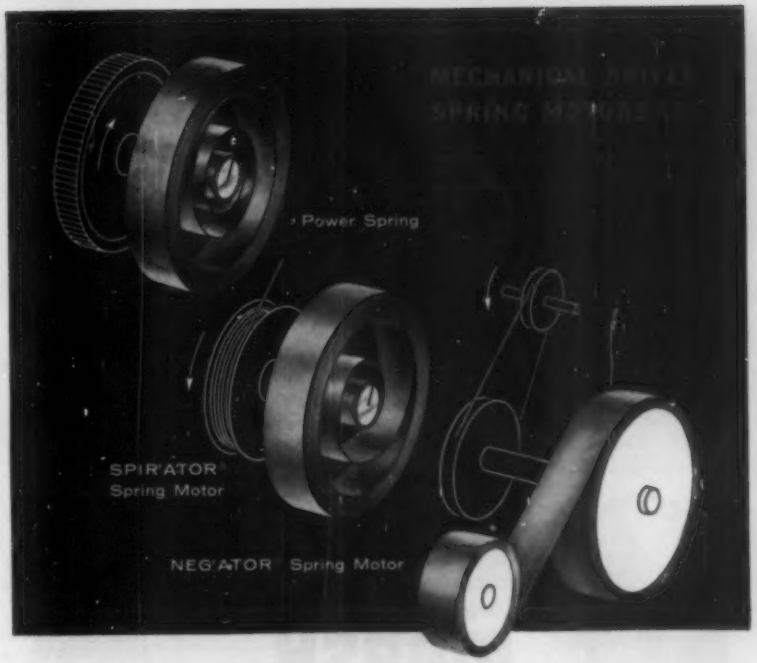
LETTERHEAD REQUEST ONLY

Manufacturers who published following literature asked that requests for copies be made on company letterheads.

INDUSTIAL RUBBER HOSE–Catalog, 20 pp. Contains descriptions on over 35 specific types of hose used in industry. Each product is illustrated, description of its application and construction is given, as well as size, weight, working pressure. Mercer Rubber Co, Hamilton Square, NJ.

POWER-TRANSMISSION MACHINERY–Catalog D-60, 468 pp. Describes line of mechanical power-transmission equipment with engineering drawings, dimensions, weights, prices, ratings and selection and application information. 8 pp index included. Dodge Mfg Corp, Mishawaka, Ind.

MAGNETIC DRIVES–Catalog TP-160, 12 pp. In addition to information on operating principles and perfonnance characteristics of permanent-magnet drive, brochure contains illustrations and typical applications. Tormag Products Div, Gleason Reel Corp, 740 N Plankinton Ave, Milwaukee 3.



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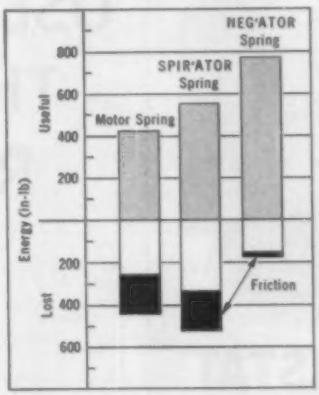

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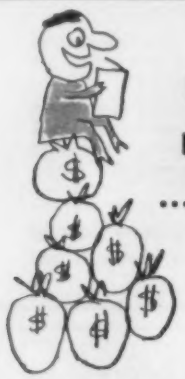

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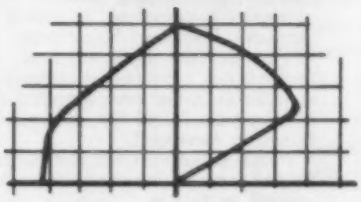

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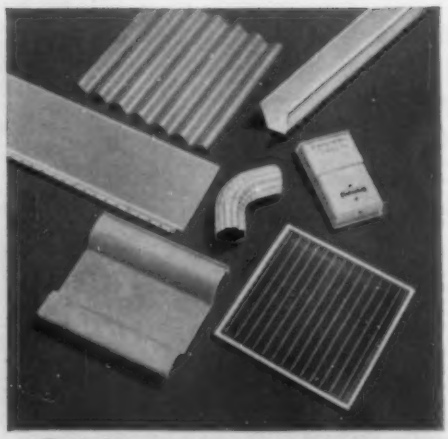

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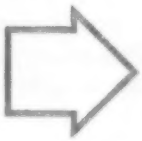

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5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
6	26	46	66	86	106	126	146	166	186	206	226	246	266	286	306	321	336	351	366	381
7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
9	29	49	69	89	109	129	149	169	189	209	229	249	269	289	309	324	339	354	369	384
10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	325	340	355	370	385
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16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
17	37	57	77	97	117	137	157	177	197	217	237	257	277	297						
18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

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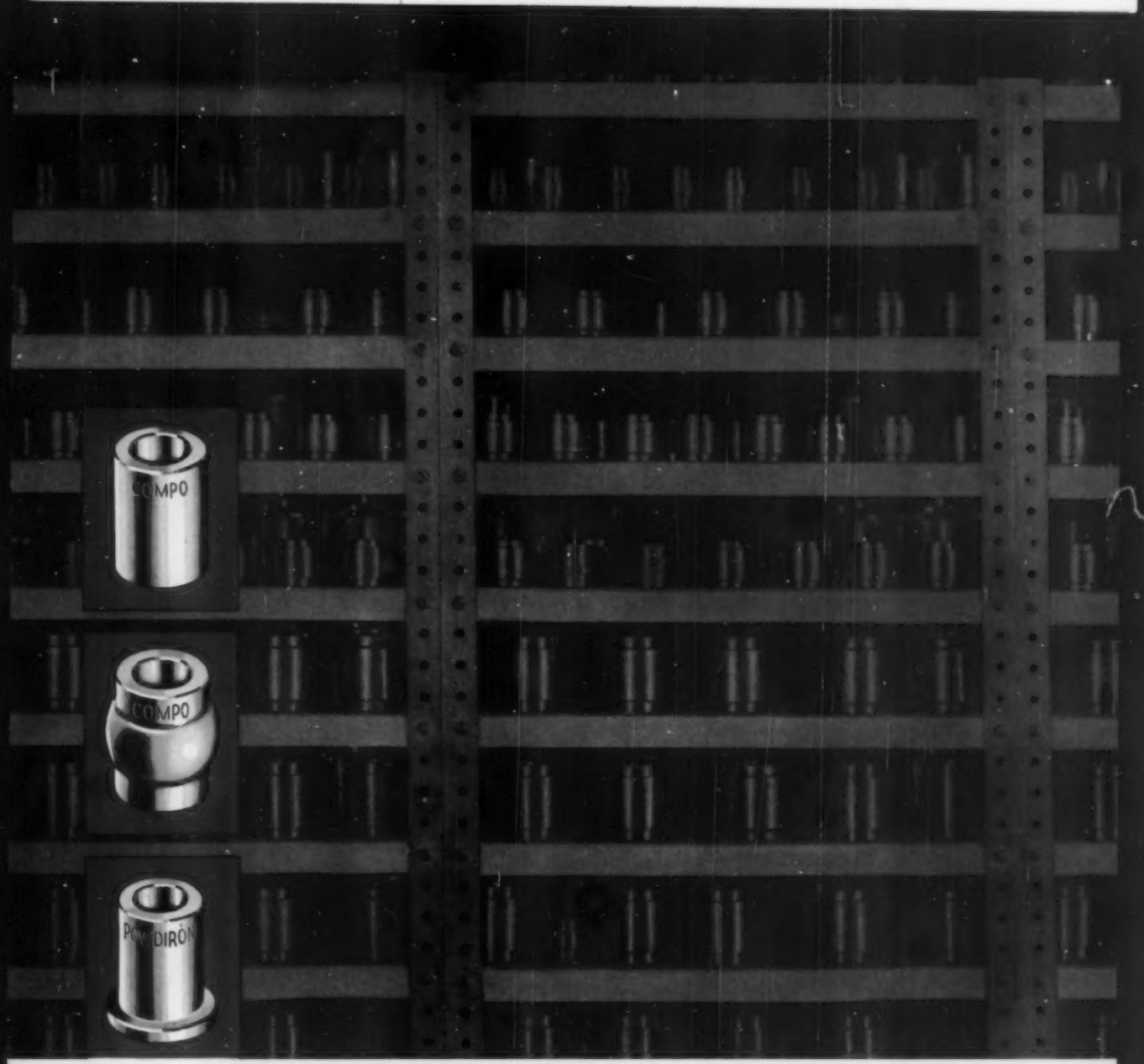

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